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ABSTRACT

This document is an instructional package prepared in objective form for use by an instructor familiar with mathematics as applied to water supply and wastewater treatment plant operation. Included are objectives, instructor guides and student handouts. The module is the first of a three level series and is concerned with calculation of circumferences, areas, volumes, storage capacity, detention time, percentage, averages, unit efficiency, and conversion of concentration to weight. (Author/RH)

BASIC MATHEMATICS

Training Module 1.301.1.77

Prepared for the

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by

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September, 1977

Module No:	Module Title: Basic Mathematics
Approx. Time: 33 hours	Submodule Titles: 1. Use of pocket calculator 2. Fractions 3. Percent 4. Statistics 5. Powers and Roots 6. Solving for one unknown 7. Flow rates/conversion of concentration to weight 8. Circumferences 9. Areas 10. Volumes 11. Detention time

Overall Objective:

Upon completion of this module the learner should be able to use the principles of basic mathematics of addition, subtraction, multiplication and division of whole numbers, fractions, and decimals as applied to water and wastewater treatment such as the calculations of circumferences, areas, volume, storage capacity, detention time, percentage, averages, unit efficiency, and the conversion of concentration to weight.

Instructional Aids:

1. Handouts
2. AV (overhead transparancy)

Instructional Approach:

1. Discussion
2. Demonstration
3. Exercise

References:

1. Workbook, Basic Mathematics and Wastewater, Processing Calculations, N. Y. Dept. of Env. Conservation
2. College Arithmetic, 2nd Edition, W. I. Layton, Wiley & Sons.
3. Study Aid Workbook, Mathematics for Wastewater Treatment Plant Operators, California Water Pollution Control Association.

Class Assignment:

1. Read handout
2. Exercise problems
3. Evaluation

Module No:	Topic: Basic Mathematics

Instructor Notes:	Instructor Outline:
1. Give handouts of each submodule title. 2. Allow sufficient time for exercises to be done. 3. Give evaluation problems.	1. Discuss/demonstrate using the student handout how one calculates using the basic principles of mathematics of addition, subtraction, multiplication and division of whole numbers, fractions and decimals as applied to water and wastewater treatment such as the calculation of circumferences, areas, volumes, storage capacity, detention time, percentage, unit efficiency and the conversion of concentration to weight.

Module No:	Module Title: Basic Mathematics
	Submodule Title:
Approx. Time: 1 hr.	Topic: Use of "Pocket" Calculator

Objectives:

The learner will demonstrate the ability to use a "pocket" calculator in:

1. Adding a group of numbers
2. Subtracting a group of numbers
3. Multiplying a group of numbers
4. Dividing a group of numbers

Instructional Aids:

Learners "pocket" calculator

Instructional Approach:

Discussion
Demonstration

References:

Manufacturers instructions of learners "pocket" calculator

Class Assignments:

1. Given 10 exercise problems to be solved involving simple arithmetic calculations.

2. Given 10 exercise problems involving a combination of arithmetic calculations

Module No:	Topic: Use of "Pocket" Calculator

Instructor Notes:	Instructor Outline:
1.	1. Demonstrate how one should use his calculator.
2. Handout exercise problems	2. Provide simple problems involving a. Addition b. Subtraction c. Multiplication d. Division
3. Handout exercise problems	3. Provide problems involving 2 or more arithmetic steps of: a. Addition b. Subtraction c. Multiplication d. Division

USE OF POCKET CALCULATOR

The important steps one has to take in solving a mathematical problem using a pocket calculator is to know how your calculator functions.

1. Take your calculator and make it count by 2's to 18.

2. Take your calculator and make it display 2401 using the number 7 only. Hint use the multiplication key.

Exercise

1. How many of these addition problems have the same answer.

a	b	c	d	e
5755	145894	796193	20067	6998
750	139354	789453	13527	458

2. How many of these subtraction problems have the same answer.

a	b	c	d	e	f
3776	10025	2995	2552	9655	74590
1445	7694	656	221	7224	72259

3. How many of these multiplication problems have the same answer.

a	b	c	d	e
82136	2180.6	10267	6128	41068
x 12	x 452	x 96	x 62	x 24

4. Find the answer to

a. 642 x 318 x 2 =

b. 12 x 12 x 12 =

c. 124 x 72 x 6 =

d. 65 x 5 x 11 x 785 =

5. How many of these division problems have the same answer.

a	b	c	d	e
1512	18424	272272	46576	3500
÷ 45	÷ 658	÷ 9724	÷ 568	÷ 125

6. Find the answer to

a. $6912 \div 4 \div 8 \div 6 =$

b. $225792 \div 28 \div 36 =$

c. $61248 \div 116 \div 44 \div 8 \div 2.5 =$

7. Without the use of a pencil or paper find the answer to:

a. $\frac{1120 \times 77}{50} =$

b. $\frac{667589}{8.34} \times 15 =$

c. $\frac{15.4}{8.34 \times 4.8} =$

d. $\frac{28.66 \times 5}{7.48 \times .7 \times 19} =$

Module No:	Module Title: Basic Mathematics
	Submodule Title: Use of "Pocket" Calculator
Approx. Time: 15 Min.	EVALUATION

Objectives:

The learner will demonstrate the ability to determine correctly the answers to 3 out of 3 problems using the learners "pocket" calculator

1. $162 - 118 + 123 - 110 - 0.82 + 6.5 - 17 + 4 =$

2. $1.55 \times .05 \times 1.9 \times .00742 \times 896543 =$

3. $\dfrac{35 \times 35 \times 8.5 \times 3.14 \times 7.48}{2320 \times 60}$ ___

Module No:	EVALUATION

Instructor Notes:	Instructor Outline:
1. Handout Answers: 1. 49.68 2. 979.55839 3. 1.7569	Give 3 evaluation questions

Module No:	Module Title: Basic Mathematics
	Submodule Title: Fractions
Approx. Time: 1 hr.	Topic: Similar Fractions

Objectives:
The learner will demonstrate the ability to:

1. Add similar fraction
2. Subtract similar fraction
3. Multiply similar fraction
4. Divide similar fraction

Instructional Aids:

Handout

AV (overhead transparancy)

Instructional Approach:

Discussion
Demonstration
Exercise

References:

Workbook, Basic Mathematics and Wastewater, Processing Calculations, N. Y. Dept. of Env. Conservation

Study Aid Workbook, Mathematics for Wastewater Treatment Plant Operators, California Water Pollution Control Association.

Class Assignments:
Give 12 exercise problems to be solved.

Module No:	Topic: Similar Fraction
Instructor Notes:	Instructor Outline:
1. Handout	1. Define similar fraction 2. Discuss/demonstrate how one adds similar fractions 3. Discuss/demonstrate how one subtracts similar fractions 4. Discuss/demonstrate how one multiplies similar fractions 5. Discuss/demonstrate how one divides similar fractions 6. Give 12 exercise problems to be solved

Common Fractions

A common fraction is a number which is the dividend, called the fraction's numerator is divided by another number which is the divisor called the fraction's denominator.

Example: $2 \div 5 = \frac{2}{5}$ or 2/5

Similar Fractions

Are fractions that have the same denominator.

Example: 6/7, 3/7, 1/7, 8/7

Addition of similar fractions.

In adding similar fractions one has to add the numerator numbers only, but the answer should retain the denominator.

Example: $5/8 + 3/8 + 7/8 = \frac{5 + 3 + 7}{8} = \frac{15}{5} =$

Exercise:

1. 14/72 + 43/72 + 61/72 + 71/72 = 1. Ans.__________
2. 1/9 + 8/9 + 5/9 + 7/9 + 2/9 = 2. Ans.__________
3. 1/4 + 2/4 + 3/4 = 3. Ans.__________

Subtraction of similar fractions

In subtracting similar fractions one has to subtract the numerator numbers only, but the answer should retain the denominator.

Example: $4/13 - 2/13 - 1/13 = \frac{4 - 2 - 1}{13} = 1/13$

Exercise:

1. 129/288 - 4/288 - 95.5/288 = 1. Ans.________
2. 62/75 - 1/75 - 41/75 - .058/75 = 2. Ans.________
3. 5/7 - 4/7 - .005/7 = 3. Ans.________

Multiplication of similar fractions

In multiplying similar fractions one has to multiply all the numerator numbers together and all the denominator numbers together.

Example: $2/7 \times 4/7 = \frac{2 \times 4}{7 \times 7} = 8/49$

Exercise:

1. 11/30 x 4/30 x 7/30 = 1. Ans.________
2. 648/415 x 28/415 x 2/415 x 385/415 = 2. Ans.________
3. 3.825/4.55 x 6.5/4.55 x 1.87/4.55 = 3. Ans.________

Dividing similar fractions

In dividing similar fractions one has to perform 3 distinct operations.

1. The divisor fraction has to be inverted.
2. The divide sign (÷) has to be changed to a multiplication sign (x)
3. Now (a) the numerator numbers are multiplied together (b) the denominator numbers are multiplied together.

Example: $2/7 \div 5/7$ or $\frac{2/7}{5/7}$

$2/7 \times 7/5 = \frac{2 \times 7}{7 \times 5} = 14/35$

Exercise:

1. $61/72 \div 65/72 =$ 1. Ans.__________

2. $\frac{431/541}{500/541} =$ 2. Ans.__________

3. $\frac{23/5}{4} =$ 3. Ans.__________

Module No:	Module Title: Basic Mathematics
	Submodule Title: Fractions
Approx. Time: 1 hr.	Topic: Dissimilar Fraction

Objectives:

The learner will demonstrate the ability to:

1. Add dissimilar fractions
2. Subtract dissimilar fractions
3. Multiply dissimilar fractions
4. Divide dissimilar fractions

Instructional Aids:

Handout

AV (overhead transparancy)

Instructional Approach:

Discussion
Demonstration
Exercise

References:

Workbook, Basic Mathematics and Wastewater, Processing Calculations, N. Y. Dept. of Env. Conservation

Study Aid Workbook, Mathematics for Wastewater Treatment Plant Operators, California Water Pollution Control Association

Class Assignments:

Give 12 exercise problems to be solved.

Module No:	Topic: Dissimilar Fractions

Instructor Notes:	Instructor Outline:
1. Handout	1. Define dissimilar fractions 2. Discuss/demonstrate how one adds dissimilar fractions 3. Discuss/demonstrate how one subtracts dissimilar fractions 4. Discuss/demonstrate how one multiplies dissimilar fractions 5. Discuss/demonstrate how one divides dissimilar fractions 6. Give 12 exercise problems to be solved.

Dissimilar Fractions

Dissimilar Fractions are fractions that do not have the same denominator.

Example: 3/4, 7/9, 16/19, 1/8

The common denominator:

In adding or subtracting dissimilar fractions one has to change the fractions to similar fractions. This can be accomplished by the least common denominator principle or by the common denominator principle. The common denominator principle is the simplest and will be discussed in this module to convert dissimilar fractions to similar fractions.

1. Multiply the denominators together. The value obtained is the new denominator for all the fractions (common denominator).

2. Divide the common denominator by the denominator of the fraction and the result multiply by the numerator. The result is the new numerator.

3. Divide new numerator by common denominator to form new fraction.

Example: 3/4 + 6/9 =

a. Common denominator is 4 x 9 = 36

b. 36 ÷ 4 = 9

   9 x 3 = 27

c. New fraction is 27/36

d. 36 ÷ 9 = 4

   6 x 4 = 24

e. New fraction is 24/36

Therefore: 3/4 + 6/9 = 27/36 + 24/36 = 51/36

Addition of Dissimilar Fractions

In adding of dissimilar fractions one has to change the fractions to similar fractions and then add the numerator numbers only, but the final answer should retain the common denominator.

Example: 5/7 + 6/13 = 65/91 + 42/91 = 107/91

Exercise:

1. 1/3 + 3/4 = 1. Ans.______

2. 1/2 + 5/8 + 9/10 = 2. Ans.______

3. 4/39 + 1/3 + 4/9 = 3. Ans.______

Subtraction of Dissimilar Fractions

In subtracting dissimilar fractions one has to change the fractions to similar fractions, and then subtract the numerator numbers only, but the final answer should retain the common denominator.

Example: 7/9 - 9/13 = 91/117 - 81/117 = 10/117

Exercise:

1. 3/7 - 2/4 = 1. Ans.______

2. 11/13 - 3/8 - 2/25 = 2. Ans.______

3. 7/7 - 2/3 - 1/4 = 3. Ans.______

Multiplication of Dissimilar Fractions

In multiplying dissimilar fractions one has to multiply all the numerator numbers together and all the denominator numbers together.

Example: 3/4 x 2/3 = 6/12

Exercise:

1. 9/50 x 25/36 = 1. Ans.______

2. 6/15 x 25/48 x 91/100 = 2. Ans.______

3. 12/25 x 69/144 x 830/2433 = 3. Ans.______

Dividing Dissimilar Fractions

In dividing dissimilar fractions one has to perform 3 distinct operations:

1. The divisor fraction has to be inverted.

2. The divide sign (÷) has to be changed to a multiplication sign (x)

3. Now (a) the numerator numbers are multiplied together and (b) the denominator numbers are multiplied together.

Example: $6/25 \div 20/99$, or $\frac{6/25}{20/99}$ $\frac{\text{(divided)}}{\text{divisor}}$ $\frac{\text{Numerator}}{\text{Denominator}}$

$$6/25 \times 99/20 = \frac{6 \times 99}{25 \times 20} = \frac{594}{500}$$

Exercise:

1. $7/8 \div 21/24 =$ 1. Ans.__________

2. $\frac{11/20}{99/80} =$ 2. Ans.__________

3. $3/4 \div 5/4 \div 21/35 =$ 3. Ans.__________

Module No:	Module Title: Basic Mathematics
	Submodule Title: Fractions
Approx. Time: ½ hr.	Topic: Mixed Numbers

Objectives:

The learner will demonstrate the ability to change mixed numbers to dissimilar fractions.

Instructional Aids:

Handout

AV (overhead transparancy)

Instructional Approach:

Discussion
Demonstration
Exercise

References:

Workbook, Basic Mathematics and Wastewater Processing Calculations, N. Y. Dept. of Env. Conservation

Study Aid Workbook, Mathematics for Wastewater Treatment Plant Operators, California Water Pollution Control Association

Class Assignments:

Give 4 exercise problems to be solved.

Module No:	Topic: Mixed Numbers

Instructor Notes:	Instructor Outline:
1. Handout	1. Define a mixed number 2. Discuss/demonstrate how one changes mixed numbers to improper fractions by multiplying the denominator of the fraction by the whole number and adding the result to the numerator. 3. Give 4 exercise problems

Mixed Fractions

A mixed fraction is composed of 2 sections:

1st section is the whole number
2nd section is the fraction

Example: 6 1/3, 2 1/4, 65 30/103

Changing mixed numbers to dissimilar fractions

To change mixed numbers to dissimilar fractions one has to perform 3 distinct operations.

a. Multiply the denominator of the fraction with the whole number.

b. Add to the result of (a) the numerator of the whole number. The result is the new numerator.

c. Place in fraction form the result of (b) the new numerator and the denominator.

Example: Change 6 1/3 to a dissimilar fraction

Step a - 6 x 3 = 18

Step b - 18 + 1 = 19

Step c - 19/3

Exercise:

Change these mixed numbers to dissimilar numbers

1. 65 3/4 = 1. Ans.__________

2. 249 3/5 = 2. Ans.__________

3. 57 5/8 = 3. Ans.__________

4. 6418 1/3 = 4. Ans.__________

Module No:	Module Title: Basic Mathematics
	Submodule Title: Fractions
Approx. Time: 1 hour	EVALUATION

Objectives:

The learner will demonstrate the ability to determine correctly the answers to 8 out of 10 problems related to:

1. Similar fractions
2. Dissimilar fractions
3. Mixed numbers

Add

1. 1/4 + 2/3 + 3/5 + 4/7 + 5/6

   a. 15/840

   b. 7362/2520

   c. 76/448

   d. 1944/560

2. 3/5 + 3/16 + 5/8 + 10/21 + 4/15

   a. 1800/21600

   b. 25/65

   c. 5/13

   d. 416520/210600

Subtract

3. 5/19 - 4/17

   a. 9/323

   b. 1/2

   c. 9/36

   d. 20/32

4. 9/10 - 1/16 - 2/17 =

a. 18/65

b. 475/271

c. 1958/2720

d. 1/3

Multiply

5. 65/256 x 20/47 x 64/195 x 188/260

a. 1/39

b. 15641600/610022400

c. 156416/6100224

d. All of the above

6. 6/15 x 25/48 x 56/135 x 91/100 x 20/49

a. 13/64

b. 15288/476280

c. 13156/38651

d. All of the above

Divide

360/726 ÷ 126/154 ÷ 261/342

a. 1838960/23875236

b. 18960480/38236968

c. 6/55

d. 1

Combine as indicated

8. 85 2/3 + 143 1/4 - 63 3/8

   a. 2/85

   b. 165/62

   c. 170/15

   d. 15796/96

9. $\dfrac{5/8 \div 15/16}{3/7 \div 27/98}$

   a. 3/7

   b. 15120/35280

   c. 21/49

   d. All of the above

10. If water weighs 62 2/5 pounds per cubic foot, what is the weight of the water in a tank which contains 450 3/4 cubic feet.

   a. 562536/20

   b. 279003/10

   c. 281/5

   d. All of the above

Module No:	Topic: Evaluation

Instructor Notes:	Instructor Outline:
1. Handout	1. Give 10 evaluation problems
Answers	
1. b	
2. d	
3. a	
4. c	
5. d	
6. b	
7. a	
8. d	
9. d	
10. a	

Module No:	Module Title: Basic Mathematics
	Submodule Title: Percent
Approx. Time: 1 hr.	Topic: Percent

Objectives:

The learner will demonstrate the ability to calculate percent by:

1. Reducing common fractions
2. Reducing decimal fractions

Instructional Aids:

Handout

AV (overhead transparancy)

Instructional Approach:

Discussion
Demonstration
Exercise

References:

Workbook, Basic Mathematics and Wastewater, Processing Calculations, N. Y. Dept. of Env. Conservation.

Study Aid Workbook, Mathematics for Wastewater Treatment Plant Operators, California Water Pollution Control Association.

Class Assignments:

Given 10 exercise problems to be solved.

Module No:	Topic: Percent

Instructor Notes:	Instructor Outline:
1. Handout	1. Discuss/demonstrate how one changes a common fraction to percentages by: a. Dividing the numerator by the denominator. b. The answer is multiplying by 100 c. Adding the sign %
2. Handout	2. Discuss/demonstrate how one changes a decimal fraction to percentages by: a. Multiplying the decimal fraction by 100 b. Adding the sign %
	3. Give 10 exercise problems to be solved.

Percent

The term percent means a fraction with 100 being the denominator.

The sign of percent is (%)

Example: 6% = 6/100 or .06

Reducing common fractions to percent

To change a fraction to percent 3 operational steps are taken:

a. Divide the numerator by the denominator.

b. Multiply the result (a) by 100

c. Add the % sign

Example: Change 4/9 to percent

a. 4/9 = 0.4444

b. 0.4444 x 100 = 44.44

c. 44.44 %

Reducing decimal fractions to percent

To change a decimal fraction to percent 2 operational steps are taken.

a. Multiply the decimal fraction by 100

b. Add the % sign

Example: Change .52 to percent

a. .52 x 100 = 52

b. 52 %

Exercise: Change to percent

1. 111/658 =	1. Ans.______
2. 48/95 =	2. Ans.______
3. 4/71 =	3. Ans.______
4. 2000/5000 =	4. Ans.______

5. 5/8 = 5. Ans.__________

6. .05437 = 6. Ans.__________

7. 0.25 7. Ans.__________

8. .00032 = 8. Ans.__________

9. .06 ¼ = 9. Ans.__________

10. .8493 = 10. Ans.__________

Module No:	Module Title: Basic Mathematics
	Submodule Title: Percent
Approx. Time: 1 hr.	Topic: Percent Removal

Objectives:
The learner will demonstrate the ability to calculate percent removal

Instructional Aids:
Handout

AV (overhead transparancy)

Instructional Approach:
Discussion
Demonstration
Exercise

References:
Workbook, Basic Mathematics and Wastewater, Processing Calculations, N. Y. Dept. of Env. Conservation.

Study Aid Workbook, Mathematics for Wastewater Treatment Plant Operators, California Water Pollution Control Association.

Class Assignments:

Given 4 exercise problems to be solved.

Module No:	Topic: Percent Removal

Instructor Notes:	Instructor Outline:
1. Handout	1. Discuss/demonstrate how one calculates percent removal by using the formula
2. Explain that this formula is used in any parameter that is being removed as a pollutant	a. Amount in influent subtract amount in effluent
Ex.	b. Divided by amount of influent
a. BOD	c. Multiplied by 100
b. Suspended solids	d. Add the percent sign
c. Ammonia	$\frac{\text{In} - \text{Out}}{\text{In}} \times 100 = \%$ Removal
d. Phosphate	2. Give 4 exercise problems.
e. Nitrates	
f. Any parameter	

Percent Removal

The term percent removal is also known as efficiency.

Example: A plant is 92% efficient. This means that the plant removes 92% of the pollutants.

One has to keep in mind the word removal.

To calculate % removal one has to know:

a. The amount removed

b. The amount started with

The formula to use is: $\frac{\text{Influent - Effluent}}{\text{Influent}} \times 100$ or $\frac{\text{In - Out}}{\text{In}} \times 100$

Example: What is the % removal of solids if the influent concentration is 201 mg/l and the effluent concentration is 35 mg/l

Solution: $\frac{\text{In - Out}}{\text{In}} \times 100$

$\frac{201 - 35}{201} \times 100$

201 - 35 = 166 the amount of solids removed due to plant operation

$\frac{166}{201} = 0.826$

$0.826 \times 100 = 82.6\%$

Exercise:

1. What is the % removal of BOD if the influent is 185 mg/l and the effluent is 12 mg/l
Ans.________

2. The hardness of raw water is 450 mg/l. After treatment the water had a hardness of 110 mg/l. What percent of the hardness was removed due to plant operation.
Ans.________

3. What is the efficiency of the plant operation if the influent suspended solids is 165 mg/l and the effluent suspended solids is 15 mg/l.
Ans.________

4. The influent to a plant contains 28 mg/l of ammonia after passing through the primary treatment the ammonia concentration is 14 mg/l. The final effluent has a concentration of 2 mg/l.

Calculate:

a. The % removal in the primary treatment. a. Ans.________

b. The % removal in the whole plant. b. Ans.________

Module No:	Module Title: Basic Mathematics
	Submodule Title: Percent
Approx. Time: ½ hour	EVALUATION

Objectives:

The learner will demonstrate the ability to determine correctly the answers to 4 out of 6 problems, involving percent and percent efficiency (percent removal).

1. 400/700

   a. 17.5

   b. 57.14

   c. 5.354

2. What is the % removal of settleable solids in a primary treatment system if the influent is 18 ml/1000 ml and effluent is 2 ml/1000 ml.

   a. 8.889

   b. 11.1

   c. 111.1

   d. 88.89

3. Calculate the % removal of BOD if the influent is 189 mg/l and the effluent is 15 mg/l.

   a. 92.06

   b. 7.936

   c. 9.206

   d. 79.36

4. A plant has an influent of 110 mg/l of solids. The effluent has a concentration of 3.8 mg/l. Calculate the % removal.

   a. 3.455

   b. 96.55

   c. 34.55

   d. 9.655

5. What is the percent removal of ammonia if the influent has a concentration of 62 mg/l and the effluent has a concentration of 16 mg/l.

   a. 74.19

   b. 2.580

   c. 7.419

   d. 25.80

6. The influent of a plant has a concentration of 218 mg/l of BOD. After primary treatment the BOD is reduced to 150 mg/l. After secondary treatment the BOD is discharged at 21 mg/l concentration. Calculate the efficiency of the plant.

   a. 86.00

   b. 90.37

   c. 31.19

   d. 9.633

Module No:	Topic: Evaluation

Instructor Notes:	Instructor Outline:
1. Handout	1. Give 6 evalution problems.
1. b 2. d 3. a 4. b 5. a 6. b	

Module No:	Module Title: Basic Mathematics
	Submodule Title: Statistics
Approx. Time: ½ hr.	Topic: Arithmetic Mean

Objectives:

The learner will demonstrate the ability to determine the arithmetic mean (average) of a group of numbers.

Instructional Aids:

Handout

AV (overhead transparancy)

Instructional Approach:

Discussion
Demonstration
Exercise

References:

Workbook, Basic Mathematics and Wastewater, Processing Calculations, N. Y. Dept. of Env. Conservation

Study Aid Workbook, Mathematics for Wastewater Treatment Plant Operators, California Water Pollution Control Association

Class Assignments:

Given 4 exercise problems to be solved.

Module No:	Topic: Arithmetic Mean
Instructor Notes:	**Instructor Outline:**
1. Handout a. Explain a group of numbers b. Explain that arithmetic mean is the same as average	1. Discuss/demonstrate how one calculates the arithmetic mean of a group of numbers using the formula Arithmetic Mean = $\frac{\text{Sum of the group of numbers}}{\text{Number of group}}$ 2. Give 4 exercise problems

Arithmetic Mean

The arithmetic mean is another name for averages. To get the average of a group of numbers one has to add all the numbers and divide the sum by the number of the group.

Example: Find the arithmetic mean of 265, 251, 282, 272

The sum of the numbers is 1070
The number of the group is 4

Therefore: $\text{Arithmetic Mean} = \dfrac{\text{sum of group}}{\text{number of group}}$

$$= \frac{1070}{4}$$

$$= 267.5$$

Exercise

1. What is the arithmetic mean of 9.8, 9.7, 9.6, 9.8, 9.95, 9.2

   Ans._____

2. 200, 245, 262, 281, 210, 145, 192, 183, 215

   Ans._____

3. 2010, 2210, 2150, 2168, 2251

   Ans._____

4. 18, 20, 24, 22, 21, 19, 14, 20, 19, 18, 17, 19

   Ans._____

Module No:	Module Title: Basic Mathematics
	Submodule Title: Statistics
Approx. Time: ½ hr.	Topic: Median

Objectives:

The learner will demonstrate the ability to determine the median of a group of numbers.

Instructional Aids:

Handout

AV (overhead transparancy)

Instructional Approach:

Discussion
Demonstration
Exercise

References:

Workbook, Basic Mathematics and Wastewater, Processing Calculations, N. Y. Dept. of Env. Conservation.

Study Aid Workbook, Mathematics for Wastewater Treatment Plant Operators, California Water Pollution Control Association.

Class Assignments:

Given 4 exercise problems to be solved.

Module No:	Topic: Median

Instructor Notes:	Instructor Outline:
1. Handout	1. Discuss/demonstrate how one calculates the median of a group of numbers. Definition of a median is the middle number of a group of numbers. If the group of numbers is made up of an even numbers of terms, than the median is the arithmetic mean of the two middle numbers. 2. Give 4 exercise problems.

Median

The median of a group of numbers is the middle number of the group. The important step to take is to arrange the numbers in increasing value. Then choose the middle number.

Example: Find the median of 140, 135, 138, 139, 145.

Solution: 135, 138, 139, 140, 145

The middle number is 139.

There is an exception to this process. If the group of numbers count even numbered than there is no proper median, but one can add the two middle numbers and take the average of both.

Example: Find the median of 148, 165, 158, 154, 144, 155

Solution: By arranging in increasing value the group is changed to:

144, 148, 154, 155, 158, 165

Notice that the median will fall between 154 and 155.

Therefore: 154 + 155 = 309

309 ÷ 2 = 154.5

154.5 is the median of the group of numbers

Exercise: Find the median of:

1. 138, 145, 129, 248, 195, 200, 135 — 1. Ans.________
2. 158, 156, 178, 184, 222, 214, 195, 185 — 2. Ans.________
3. 201, 212, 200, 232, 227, 199, 251 — 3. Ans.________
4. 18, 20, 24, 14, 19, 13, 21, 22, 17, 16 — 4. Ans.________

Module No:	Module Title: Basic Mathematics
	Submodule Title: Statistics
Approx. Time: ½ hour	EVALUATION

Objectives:

The learner will demonstrate the ability to determine correctly the answers to 4 out of 5 problems related to:

1. Arithmetic Mean
2. Median

1. Find the arithmetic mean to 50, 38, 32, 45, 55, 62, 48, 31

   a. 42

   b. 45.1

   c. 48

   d. 31

2. Find the median to 38, 45, 55, 62, 31, 32, 68, 42, 39

   a. 46.5

   b. 31

   c. 45.1

   d. 42

3. Find the arithmetic mean to 2200, 2061, 2145, 2182, 2021, 2089, 2074

   a. 2110.3

   b. 2081.5

   c. 2089

   d. 2074

4. Find the median of 2.9, 4.8, 4.9, 5.3, 5.6, 5.4, 6.2, 2.6

   a. 4.9

   b. 5.3

   c. 5.1

   d. 4.7

5. Find the arithmetic mean to 60, 62, 60, 60, 60, 58, 61, 62, 63.5

   a. 47.4

   b. 63.5

   c. 60.7

   d. 60.0

Module No:	Topic: Evaluation

Instructor Notes:	Instructor Outline:
1. Handout	1. Give 5 evaluation problems.
Answers	
1. b	
2. d	
3. a	
4. c	
5. c	

Module No:	Module Title: Basic Mathematics
	Submodule Title: Powers and Roots
Approx. Time: 1 hour	Topic: Powers

Objectives:

The learner will demonstrate the ability to calculate:

1. The square of a number
2. The cube of a number
3. The Nth power of a number

Instructional Aids:

Handout
AV (overhead transparancy)
Calculator

Instructional Approach:

Discussion
Demonstration
Exercise

References:

Workbook, Basic Mathematics and Wastewater, Processing Calculations, N. Y. Dept. of Env. Conservation

Study Aid Workbook, Mathematics for Wastewater Treatment Plant Operators, California Water Pollution Control Association

Class Assignments:

1. Read handout
2. Given 10 exercise problems to be solved

Module No:	Topic: Powers

Instructor Notes:	Instructor Outline:
1. Handout	1. Discuss/demonstrate how one calculates the square of a number using the formula:
a. N being the number	$(N)^2 = N \times N$
b. Emphasis that if the number has a unit value (ft., inches etc.) than that unit value has to be squared or cubed also.	2. Discuss/demonstrate how one calculates the cube of a number using the formula: $(N)^3 = N \times N \times N$
c. Emphasis that the unit values of numbers have to be of the same unit.	3. Discuss/demonstrate how one calculates the Nth power of a number using the formula: $(N)^N = \underset{1}{N} \times \underset{2}{N} \times \underset{3}{N} \text{----} \underset{\text{Nth}}{XN}$
Remember one cannot multiply different unit values. Ex. ft. x inches.	4. Give 10 exercise problems.

Powers

Powers is a mathematical terminology used to indicate the product of the multiplication of a number by the same number.

Example

$2 \times 2 = 4$

4 is the power

Terminology used in calculating for powers are

a. Base = The number

b. Exponent = Number of times the number is multiplied

c. Power = The product of multiplication

Example

$(3)^2$ or 3^2 means three to the second power or $3 \times 3 = 9$

Where

a. 3 is the base

b. 2 is the exponent

c. 95 the power

The most common use of powers is a square. This is when a number is multiplied by the same number. The symbol usually is $(N)^2$.

Example

What is the square of 5

Solution

$(5)^2 = 5 \times 5 = 25$

Exercise

Calculate

1. $(16 \text{ ft.})^2$ 1. Ans.________
2. $(102 \text{ in.})^2$ 2. Ans.________
3. $(1 \text{ mile})^2$ 3. Ans.________
4. $(20 \text{ meters})^2$ 4. Ans.________

Cube

This is when a number is multiplied by the same number twice. The symbol usually = $(N)^3$

Example

What is the cube of 6

Solution

$(6)^3 = 6 \times 6 \times 6 = 216$

Exercise

Calculate

1. $(2\ \text{ft.})^3$ 1. Ans.________
2. $(51\ \text{inches})^3$ 2. Ans.________
3. $(20\ \text{meters})^3$ 3. Ans.________
4. $(1.2\ \text{yd.})^3$ 4. Ans.________

Nth power: This is an expression where the number has a specific opponent.

Example

Calculate

4 to the 5th power which is also written $(4)^5$

Solution

$(4)^5 = 4 \times 4 \times 4 \times 4 \times 4 = 1024$

Exercise

Calculate

1. $(10)^6$ 1. Ans.________
2. $(5)^8$ 2. Ans.________

Module No:	Module Title: Basic Mathematics
	Submodule Title: Powers and Roots
Approx. Time: 1 hour	Topic: Roots

Objectives:

The learner will demonstrate the ability to calculate the:

1. Square root of a number
2. Cube root of a number

Instructional Aids:

Handout
AV (overhead transparancy)
Calculator

Instructional Approach:

Discussion
Demonstration
Exercise

References:

Workbook, Basic Mathematics and Wastewater, Processing Calculations, N. Y. Dept. of Env. Conservation

Study Aid Workbook, Mathematics for Wastewater Treatment Plant Operators, California Water Pollution Control Association

Class Assignments:

1. Read handout
2. Given 10 exercise problems to be solved

Module No:	Topic: Roots

Instructor Notes:	Instructor Outline:
1. Handout	1. Discuss/demonstrate how one calculates the square root of a number using the pocket calculator or mathematicsl tables. 2. Discuss/demonstrate how one calculates the cube root of a number using a pocket calculator or a mathematical table. 3. Give 10 exercise problems.

Roots

A root of a number is one of the equal factors, which, when multiplied together, give the number.

The most common "root" problem one encounters is:

a. Square root - Symbol $\sqrt{}$

b. Cube root - Symbol $\sqrt[3]{}$

A. Since the use of pocket calculators is quite extensive and that most units have a square root key. One has only to key in the number and then key the square root key.

I. The calculator not having a $\sqrt{}$ key the easiest alternative is to:

Approximate the square of a number that is close to the actual value you are seeking.

Example: What is the square root of 38 = $\sqrt{38}$

One knows that by

a. Multiplying 6 x 6 = 36

b. Multiplying 7 x 7 = 49

Since one is seeking the $\sqrt{38}$ than the number is close to 6

If one multiplies 6.2 x 6.2 the product is 38.44.

Close but not quite, but one should see that the number being sought is between 6.1 and 6.2.

Try 6.15

6.15 x 6.15 = 37.8225

Try 6.16

6.16 x 6.16 = 37.9456

Try 6.165

6.165 x 6.165 = 38.007285

REMEMBER that the calculator can do your work (multiplication) much quicker than you. So, start with an educated guess and work your way towards that number you are seeking.

Exercise

1. $\sqrt{354} =$ 1. Ans.________

2. $\sqrt{16} =$ 2. Ans.________

3. $\sqrt{4.4} =$ 3. Ans.________

4. $\sqrt{20655} =$ 4. Ans.________

5. $\sqrt{1,000,000} =$ 5. Ans.________

B. Cube Root - To calculate the cube root of a number follow the same principle applied in square root but this time one has to multiply the number being sought 3 times.

Example: The cube root of $\sqrt[3]{27}$ is 3

$3 \times 3 \times 3 = 27$

Exercise

1. $\sqrt[3]{648} =$ 1. Ans.________

2. $\sqrt[3]{125} =$ 2. Ans.________

3. $\sqrt[3]{189554} =$ 3. Ans.________

4. $\sqrt[3]{125000} =$ 4. Ans.________

5. $\sqrt[3]{729000} =$ 5. Ans.________

Module No:	Module Title: Basic Mathematics
	Submodule Title: Powers and Roots
Approx. Time: ½ hour	EVALUATION

Objectives:

The learner will demonstrate the ability to calculate correctly the answers to 4 out of 5 problems related to powers and roots of numbers.

1. The square root of 15625 is
   a. 225
   b. 7812.5
   c. 5208.3
   d. 125

2. The cube root of 1953125 is
   a. 125
   b. 651041.66
   c. 5
   d. 15625

3. The formula of the volume of a cube is $(L)^3$. If L = 25 ft. what is the volume
   a. 15625 cubic feet
   b. 75 cubic feet
   c. 1953125 cubic feet
   d. 625 cubic feet

4. A formula is $A = 3.14 \times R^2$. If R is 50 ft. calculate for A
   a. 314 sq. ft.
   b. 7850 sq. ft.
   c. 157 sq. ft.
   d. 22.2 sq. ft.

5. What is the cube of 65.

   a. 4.02

   b. 195

   c. 390

   d. 274625

Module No:	EVALUATION

Instructor Notes:	Instructor Outline:
1. Handout	1. Give 10 evaluation problems
Answers	
1. d	
2. a	
3. a	
4. b	
5. b	

Module No:	Module Title: Basic Mathematics
	Submodule Title: Solving for one unknown
Approx. Time: 1 hr.	Topic: Simple linear equation using addition and subtraction principles

Objectives: The learner will solve for the unknown in a simple linear equation using the addition and/or subtraction principles.

Instructional Aids:

Handout

Instructional Approach:

Discussion
Demonstration
Exercises

References:

Workbook, Basic Mathematics and Wastewater Processing Calculations, N. Y. Dept. of Env. Conservation

College Arithmetic, 2nd Edition, W. I. Layton, Wiley & Sons

Class Assignments:

Given 10 simple linear equations to be solved using the addition principle.

Given 10 simple linear equations to be solved using the subtraction principle

Module No:	Topic: Simple linear equation using addition and subtraction principles

Instructor Notes:	Instructor Outline:
Handout	1. Discuss/demonstrate how one solves for an unknown in a simple linear equation using the addition principle.
	a. Give 10 exercise problems
Handout	2. Discuss/demonstrate how one solves for an unknown in a simple linear equation using the subtraction principle.
	a. Give 10 exercise problems

SOLVING FOR ONE UNKNOWN (SIMPLE LINEAR EQUATIONS)

In solving for an unknown number, the fundamental operations of addition, subtraction, multiplication, and division will be used.

In mathematics one has to remember that:

1. Addition is the opposite of subtraction.
2. Multiplication is the opposite of division.

Addition

What number is added to 10 to equal 25. This statement can be written as:

$? + 10 = 25$

In Algebra rather than use the symbol ? the symbol x is used so:

Let us look again at the problem

$X + 10 = 25$

Therefore: $x = 15$

Since this example is a simple one, one should be able to see the problem changes from:

$x + 10 = 25$

$x = 25 - 10$

$x = 15$

Three actions were done:

1. The sign (+) and number (10) were moved to the other side of the equal sign (=).

2. The positive sign (+) is changed to the opposite sign (negative) (-).

3. The mathematical computation is done (subtract 10 from 25).

Since one is solving for an unknown, the symbol for the unknown number does not have to be x it could be y or A or C or V or Q.

Just remember the equation (formula) would have only one unknown.

Solve for the unknown:

1.	$x + 13 = 17$	Ans. $x =$
2.	$x + 9 = 15$	$x =$
3.	$A + 6 = 21$	$A =$
4.	$C + 118 = 366$	$C =$
5.	$Q + 711 = 741$	$Q =$
6.	$V + 16.75 = 24.65$	$V =$
7.	$R + 16 = 72$	$R =$
8.	$P + 61 = 75$	$P =$
9.	$Q + 10 = 17$	$Q =$
10.	$Q + 10 = 27$	$Q =$

Subtraction

What number can 5 be subtracted from to get 25. This statement can be written $x - 5 = 25$

The answer is 30

Again remember that x is only a symbol indicating the unknown number. The symbol could be anything identifying the unknown number.

1. The sign (-) and the number 5 were moved to the other side of the equal sign (=).
2. The negative sign (-) is changed to the opposite sign (positive) (+).
3. The mathematical computation is done (add 5 to 35)

Then so: $x - 5 = 25$

$x = 25 + 5$

$x = 30$

Solve for the unknown:

1. $x - 14 = 28$ Ans. $x =$
2. $x - 5 = 15$ $x =$
3. $x - 25 = 30$ $x =$
4. $R - 19 = 1$ $R =$
5. $Q - 34 = 6$ $Q =$
6. $P - 48 = 12$ $P =$
7. $x - 60 = 40$ $x =$
8. $y - 24 = 116$ $y =$
9. $W - 43 = 473$ $W =$
10. $x - 49 = 851$ $x =$

Module No:	Module Title: Basic Mathematics
	Submodule Title: Solving for one unknown
Approx. Time: 1 hr.	Topic: Simple linear equation using multiplication and division principles

Objectives: The learner will solve for the unknown in a simple linear equation using the addition and/or multiplication principles.

Instructional Aids:

Handout

Instructional Approach:

Discussion

References:

Workbook, Basic Mathematics and Wastewater Processing Calculations, N. Y. Dept. of Env. Conservation

College Arithmetic, 2nd Edition, W. I. Layton, Wiley & Sons

Class Assignments:

Given 10 simple linear equations to be solved using the multiplication principle.

Given 10 simple linear equations to be solved using the division principle.

Module No:	Topic: Simple linear equation using multiplication and division principles
Instructor Notes:	**Instructor Outline:**
Handout	1. Discuss/demonstrate how one solves for an unknown in a simple linear equation using the multiplication principle.
	1 a. Give 10 exercise problems
Handout	2. Discuss/demonstrate how one solves for an unknown in a simple linear equation using the division principle.
	2 a. Give 10 exercise problems.

Multiplication

What number is multiplied by 2 to get 10.

X x 2 = 10 Ans. 5

Three actions were done:

1. The multiplication sign (x) and the number 2 is moved to the other side of the equal sign (=).
2. The multiplication sign (x) is changed to the opposite sign division (÷).
3. The mathematical computation is done (divide 10 by 2).

The equation

X x 2 = 10

Becomes

x = 10 ÷ 2

Answer x = 5

Solve for the unknown:

1.	X x 6 = 72	Ans. X =
2.	P x 10 = 400	P =
3.	R x 5 = 35	R =
4.	S x 15 = 75	S =
5.	Q x 35 = 140	Q =
6.	Y x 28 = 56	Y =
7.	X x 11 = 121	X =
8.	Q x 115 = 345	Q =
9.	W x 400 = 800	W =
10.	X x 8 = 32	X =

Division

What number is divided by 4 to get 12. This statement can be written:

$x \div 4 = 12$ Ans. 3

Three actions were done:

1. The division sign ($\div$) and the number 4 were moved to the other side of the equal sign (=).
2. The division sign ($\div$) was changed to the opposite sign (x).
3. The mathematical computation is done (multiply 12 by 4).

The equation

$x \div 4 = 12$

Becomes

$x = 12 \times 4$ Ans. 48

Solve for the unknown:

1. $X \div 5 = 25$ Ans. X =
2. $P \div 6 = 12$ P =
3. $W \div 9 = 10$ W =
4. $Q \div 10 = 16$ Q =
5. $Q \div 11 = 33$ Q =
6. $X \div 2 = 100$ X =
7. $Y \div 4 = 32$ Y =
8. $M \div 30 = 120$ M =
9. $R \div 65 = 260$ R =
10. $S \div 4.5 = 9$ S =

Module No:	Module Title: Basic Mathematics
	Submodule Title: Solving for one unknown
Approx. Time: 1 hr.	Topic: Simple linear equation using addition, subtraction multiplication and division principles.

Objectives:

The learner will solve for the unknown in a simple linear equation (a formula) using addition, subtraction, multiplication and/or division principles.

Instructional Aids:

Handout

Instructional Approach:

Discussion
Demonstration
Exercises

References:

Workbook, Basic Mathematics and Wastewater Processing Calculations, N. Y. Dept. of Env. Conservation

College Arithmetic, 2nd Edition, W. I. Layton, Wiley & Sons

Class Assignments:

Given 4 simple linear equations to be solved using the addition, subtraction, multiplication and division principles.

<table>
<tr><td>Module No:</td><td colspan="2">Topic:
Simple linear equation using addition, subtraction multiplication and division principles.</td></tr>
<tr><td colspan="2">Instructor Notes:</td><td>Instructor Outline:</td></tr>
<tr><td colspan="2">Handout</td><td>1. Discuss/demonstrate how one solves for an unknown in a simple linear equation (a formula) using addition, subtraction, multiplication and/or division principles.
1 a. Give 4 exercise problems.</td></tr>
</table>

FORMULAS

A formula is an equation in which the letters refer to definite quantities. To find the value of any letter (also known as the unknown) in a formula when the values of the other letters are given, write down the formula, substitute the values that are given for the letters, and carry out the necessary operations (addition, subtraction, multiplication and/or division.

Example 1

In the formula $A = \pi \times D$, find the value of A when $\pi = 3.14$ and $D = 5$

Solution

$A = \pi \times D$

$A = 3.14 \times 5$

$A = 15.7$

Example 2

In the formula $A = LW$, find the value of L when $A = 60$ and $W = 6$

Solution

$A = LW$

$60 = L \times 6$

Now what number is multiplied by 6 to give an answer of 60. Ans. 10. The answer was obtained by:

1. The multiplication sign (x) and the number 6 moved to the other side of the equal sign (=).

2. The multiplication sign (x) changed to the opposite sign, division (÷).

3. The mathematical computation is done. (Divide 60 by 6).

The equation

$A = LW$

Becomes

$60 = L \times 6$

Which becomes.

$60 \div 6 = L$

Therefore

$10 = L$

$10 = L$

Is the same as

$L = 10$

Example 3

In the formula $V = 1/3\ LWH$, find the value of V when $L = 15$, $W = 10$ and $H = 6$

Solution

$V = 1/3\ LWH$

$V = 1/3 \times 15 \times 10 \times 6$

$V = \frac{1 \times 15 \times 10 \times 6}{3}$

$V = \frac{900}{3}$

$V = 300$

Exercise: Solve for the unknown

1. $C = L + W$
   When $L = 10$, $W = 3$ Ans._____

2. $M = \frac{a}{b}$
   When $a = 9$ and $b = 6$ Ans._____

3. $A = 1/2 \times b \times h$
   When $b = 18$, and $h = 8$ Ans._____

4. $A = 2 \times \pi \times R \times h$
   When $\pi = 3.14$, $R = 4$, and $h = 40$ Ans._____

Module No:	Module Title: Basic Mathematics
Approx. Time: 1 hour	Submodule Title: Solving for one unknown
	EVALUATION

Objectives:

The learner will demonstrate the ability to determine the correct answers to 8 out of 10 problems related to a simple linear equation using addition, subtraction, multiplication and division principles.

1. $V = L \times W \times H$
   when $L = 4$, $W = 3$ & $H = 10$

   a. 120

   b. 17

   c. 85

2. $C = \pi \times D$
   When $\pi = 3.14$, and $D = 20$

   a. 62.8

   b. 1256.0

   c. 31.4

   d. 6280

3. $A = \frac{1}{2} b \times h$
   When $b = 18$, and $h = 8$

   a. 144

   b. 288

   c. 4.5

   d. 72

4. $A = 2 \times \pi \times R \times h$
   When $\pi = 3.14$, $R = 4$, and $h = 10$

   a. 62.8

   b. 125.6

   c. 251.2

5. $V = 1/3 \times \pi \times R^2 \times h$
When $\pi = 3.14$, $R = 6$, and $h = 2$

a. 12.56

b. 226.08

c. 25.12

d. 75.36

6. $A = \pi \times R^2$
When $\pi = 3.14$ and $R = 25$

a. 157.0

b. 1962.5

c. 7850

d. 314

7. $A = L \times W$
When $L = 40$ and $W = 30$

a. 12

b. 120

c. 1200

d. 70

8. $M = \frac{a}{b}$
When $a = 9$ and $b = 6$

a. 54

b. 1.5

c. .666

9. $A = (L)^2$
When $L = 15$

a. 30

b. 225

c. 3.87

10. $DT = \frac{V}{Q}$

When V = 65,485 and Q = 30,500

a. 1,997,200,000

b. 2.15

c. 0.47

Module No:	Topic: Evaluation

Instructor Notes:	Instructor Outline:
1. Handout	1. Give 10 problems
1. a	
2. a	
3. d	
4. c	
5. d	
6. b	
7. c	
8. b	
9. b	
10. b	

Module No:	Module Title: Basic Mathematics
	Submodule Title: Flow Rate
Approx. Time: 2 hrs.	Topic: Conversion

Objectives: The learner will demonstrate the ability to convert:

1. Cubic feet to gallons
2. Cubic feet per second to cubic feet per day
3. Gallons per second to million gallons per day

Instructional Aids:

Handout
AV (overhead)

Instructional Approach:

Discussion
Demonstration
Exercise

References:

Workbook, Basic Mathematics and Wastewater, Processing Calcultions, N. Y. Dept. of Env. Conservation

Study Aid Workbook, Mathematics for Wastewater Treatment Plant Operators, California Water Pollution Control Association

Class Assignments:

1. Given 20 exercise problems to be solved.

Module No:	Topic: Conversion

Instructor Notes:	Instructor Outline:
Handout	1. Discuss/demonstrate conversion of cubic feet to gallons Gal = cu. ft. x 7.48 a. Give 4 exercise problems 2. Discuss/demonstrate conversion of gallons to cubic ft. $\text{Cu. ft.} = \frac{\text{Gal}}{7.48}$ a. Give 4 exercise problems 3. Discuss/demonstrate conversion of cubic feet/sec. to cubic ft./day CFS → CFM → CFH → CFD a. Give 4 exercise problems 4. Discuss/demonstrate conversion of gallons per second to gallons per day. GPS → GPM → GPH → GPD a. Give 4 exercise problems 5. Discuss/demonstrate conversion of gallons per day to million gallons per day. MGD = GPD ÷ 1,000,000 a. Give 4 exercise problems.

Conversion

Conversion of cubic feet to gallons

One cubic foot of water is equal to 7.48 gallons. Therefore to convert cubic feet to gallons one has to multiply the volume in cubic feet by 7.48

The formula to use is:

Gallons = cu. ft. x 7.48

Example: Change 350 cubic feet to gallons

Solution: Gal = cu. ft. x 7.48

= 350 x 7.48

= 2618 gallons

Exercise:

1. The volume of a tank is 6200 cubic feet. How many gallons does this represent?

Ans._____

2. A lagoon holds 1,000,000 cubic feet of water. How many gallons of water does the lagoon hold?

Ans._____

3. A sedimentation tank has the capacity of 4580 cubic feet of water. How many gallons does that represent?

Ans._____

4. A water main has a capacity of 1800 cubic feet. How many gallons does that make?

Ans._____

Conversion of gallons to cubic feet

One cubic foot of water is equal to 7.48 gallons. To convert gallons to cubic feet one has to divide the volume in gallons by 7.48.

The formula to use is: $\text{Cu. ft.} = \dfrac{\text{gallons}}{7.48}$

Example: Change 350,000 gallons to cubic feet.

Solution: $\text{Cu. ft.} = \dfrac{\text{gal.}}{7.48}$

$= \dfrac{350,000}{7.48}$

$= 46791.44$ cu. ft.

Exercise

1. Convert 1,538,000 gallons to cubic feet.

   Ans._____

2. A tank holds 655,000 gallons. How many cubic feet does equal to.

   Ans._____

3. A house uses 8500 gallons of water. How many cubic feet does this equal?

   Ans._____

4. Convert 258542 gallons to cubic feet.

   Ans._____

<u>Conversion of cubic feet/second to cubic feet/day</u>

To convert cu. ft./sec. to cu. ft./day one can use the flow chart

CFS ⟶ CFM ⟶ CFH ⟶ CFD

Where:

CFS = cu. ft./sec.

CFM = cu. ft./min.

CFH = cu. ft./hour

CFD = cu. ft./day

One has to remember that the variable between the different stages of the flo chart is time (sec., min., Hr., day). Therefore by multiplying the cubic fee sec. x 60 changes the value to CFM and CFM x 60 to CFH and CFH x 24 = CFD

Example: Change 3 CFS to CFD

Solution: CFS ⟶ CFM ⟶ CFH ⟶ CFD

3 x 60 = 180 CFM

180 x 60 = 10800 CFH

10800 x 24 = 259200 CFD

In retrospect, to change CFD to CFS one has to divide the value in CFD by 24 to obtain CFH, CFH by 60 to obtain CFM and CFM by 60 to obtain CFS.

Example: Change 129654 CFD to CFS

Solution:

CFD ÷ 24 = CFH

CFH ÷ 60 = CFM

CFM ÷ 60 ÷ CFS

129654 ÷ 2.4 = 2160.9 CFH

2160.9 ÷ 60 = 36.015 CFM

36.015 ÷ 60 = 0.600 CFS

Exercise:

1. Change 5 CFS → CFD Ans._____
2. Change 35 CFS → CFD Ans._____
3. Change 345600 CFD to CFS Ans._____
4. Change 1,296,000 CFD to CFS Ans._____

Conversion of gallons/second to million gallons/day

To convert gallons/second to million gallons/day one can use the flow chart

GPS → GPM → GPH → GPD → MGD

Where:

GPS = gallons/second

GPM = gallons/minute

GPH = gallons/hour

GPD = gallons/day

MGD = million gallons/day

One has to remember that the variable is the time (sec., min., hr., day) Therefore multiplying GPS x 60 changes the value to GPM and GPM x 60 to GPH and GPH x 24 = GPD

Example: Change 5 GPS to GPD

Solution: GPS → GPM → GPH → GPD

5 x 60 = 300 GPM

300 x 60 = 18000 GPH

18000 x 24 = 432000 GPD

The principle of million gallons/day is that the value is a fraction of a million

Example 1

5,000,000 gallons/day = 5 MGD

That is 5 MGD is 5 one million gallons

Example 2

650,000 gallons/day = .65 MGD

That is 65/100 of a million gallons

Therefore to change GPD to MGD divide GPD by 1,000,000

Example: Change 251,000 gallons/day to MGD.

Solution: $MGD = \frac{GPD}{1,000,000}$

$= \frac{251,000}{1,000,000}$

$= .251$

Exercise

1. Change 18 GPS to GPD Ans._____
2. Change 0.5 GPS to GPD Ans._____
3. Change 345600 GPD to GPS Ans._____
4. A pump is rated at 3 GPS. If the pump operates for 24 hrs. how many gallons was pumped? Ans._____

Change:

1. 345600 GPD to MGD 1. Ans.________

2. 0.8 GPS to MGD 2. Ans.________

3. If a pump is rated at 5 GPS and it operates for 24 hours how many MGD did it pump? 3. Ans.________

4. If a pump is rated at 22 GPS and it operates for a total of 13.5 hours a day, how many gallons in (MGD) did it pump? 4. Ans.________

Module No:	Module Title: Basic Mathematics
	Submodule Title: Weight (pounds)
Approx. Time: 1 hr.	Topic: Conversion

Objectives:

The learner will demonstrate the ability to convert concentration (mg/l) to pounds.

Instructional Aids:

Handout

AV (overhead transparancy).

Instructional Approach:

Discussion

Demonstration

Exercise

References:

Workbook, Basic Mathematics and Wastewater Processing Calculations, N. Y. Dept. of Env. Conservation

Study Aid Workbook, Mathematics for Wastewater Treatment Plant Operators, California Water Pollution Control Association

Class Assignments:

1. Given 4 exercise problems to be solved.

Module No:	Topic: Conversion
Instructor Notes:	**Instructor Outline:**
I. Handout a. Emphasize that ppm is the same as mg/l b. Q has to be in million gallons	1. Discussion/demonstration conversion of concentration to pounds lbs. = mg/l x 8.34 x Q mg/l = concentration Q = flow rate or volume of water in million gallons a. Give 4 exercise problems

Conversion of Concentration to Pounds

To convert concentrations of parameters obtained from lab tests to pounds (weight) one has to use the formula:

lbs. = Mg/l. x 8.34 x Q

lbs. = pounds

mg/l = concentration of parameter such as Cl_2, BOD, NH_3, N, TSS etc.

8.34 = 1 gallon of water weights 8.34 pounds

Q = flow rate

Remember that Q can be the volume of a tank in million gallons (MG) or the flow rate in to pump in million gallons per day (MGD)

Example: How many pounds of Cl_2 is added if the concentration = A, 1.5 million gallons water tank is 2.8 mg/l

Solution: lbs. = mg/l x 8.34 x Q

= 2.8 x 8.34 x 1.5

= 35.03 lbs.

KEEP IN MIND THAT THIS FORMULA IS A KEY FORMULA IN WATER AND WASTEWATER TECHNOLOGY AND IS USED CONSISTENTLY.

Exercise

1. The flow into a plant is 355000 GPD. The concentration of BOD discharged is 21 mg/l. How many lbs. of BOD is being discharged that day?

   1. Ans.________

2. You have determined that you need a concentration of 2 mg/l of chlorine to be added to a flow of 3 MG tank. How many lbs. of Cl_2 is needed?

   2. Ans.________

3. If your lab results indicate that the total suspended solids is 185 mg/l the flow is .54 MGD. How many lbs. of TSS is present in the flow?

   3. Ans.________

4. A pump pumps at a rate of 65 GPS. The total hours the pump works is 11 hrs. The concentration is .2 mg/l. How many pounds of flouride is needed to make up the concentration up to 1 mg/l?

   4. Ans.________

Module No:	Module Title: Basic Mathematics
	Submodule Title: Flow Rate and Weight
Approx. Time: 1 hour.	EVALUATION

Objectives:

The learner will demonstrate the ability to determine correctly the answers to 8 out of 10 problems related to the conversion of:

1. Cubic feet to gallons
2. Cubic feet per second to million gallons per day
3. Concentration (mg/l) to pounds

1. Convert 60 cu. ft. to gallons

   a. 448.8

   b. 8.02

   c. 750.6

2. Convert 187 gallons to cu. ft.

   a. 22.42

   b. 1398.76

   c. 25

3. Convert 80 GPS to GPD

   a. 115,200

   b. 6,912,000

   c. 861,696

4. Convert 12 CFS to MGD

   a. .323

   b. .129

   c. 7.755

5. Convert 12158 GPH to MGD

a. .292

b. 17,507,520

c. 291792

d. 4863.2

6. Convert 0.864 MGD to GPS

a. 1.34

b. 600

c. 10

d. 1

7. A pump pumps at 350 GPM. If it operates only for 3.8 hours, how many lbs. of solids did it pump to the plant if the solids concentration is 168 mg/l.

a. 706.15

b. 1.86

c. 111.81

d. 79.42

8. A tank has a volume of 2,462,000 gallons. How many pounds of Cl_2 is needed to have a concentration of 0.8 mg/l (assume no demand).

a. 16.43

b. 1.64

c. 164.26

d. 2.20

9. Your raw water has a concentration of 1.8 mg/l of iron. How many pounds of iron is removed if the discharge is 0.02 mg/l and the flow per day is 36000 cubic feet.

a. 4.042

b. 0.479

c. 1.000

d. 2.007

10. How many pounds of BOD is discharged into a stream from a plant with a flow of 785,000 gallons and a concentration of 35 mg/l.

a. 22.91

b. 27.48

c. 229.14

d. 2291.4

Module No:	Topic: EVALUATION

Instructor Notes:	Instructor Outline:
1. Handout Answers 1. a 2. c 3. b 4. c 5. a 6. c 7. c 8. a 9. d 10. c	1. Give 10 evaluation problems.

Module No:	Module Title: Basic Mathematics
	Submodule Title: Circumferences
Approx. Time: 1 hr.	Topic: Rectangles/triangles/circles/trapizoids

Objectives:

The learner will demonstrate the ability to determine the ci.cumference of rectangles, triangles, circles and trapizoids.

Instructional Aids:

Handout

AV (Overhead transparancy)

Instructional Approach:

Discussion
Demonstration
Exercises

References:

Workbook, Basic Mathematics and Wastewater Processing Calculations, N. Y. Dept. of Env. Conservation

College Arithmetic, 2nd Edition, W. I. Layton, Wiley & Sons

Class Assignments:

1. Given 16 problems as exercise. 4 Problems per geometric figure.

Module No:	Topic: Rectangles, triangles, circles, trapizoids
Instructor Notes:	**Instructor Outline:**
Handout	1. Discuss/demonstrate how one calculates the circumference of a. Rectangles $C = 2L + 2W$ b. Triangles $C = a + b + c$ c. Circle $C = \pi D$ or $= 2\pi R$ d. Trapizoids $C = a + b + c + d$ 2. Each geometric figure has 4 problems to be used as exercise.

Rectangle

The circumference of a rectangle is the sum of all four sides of the figure.

The answer has linear unit values (feet, yds, meters, etc.)

Formula

$C = L + L + W + W$ or $C = 2L + 2W$

Example: Find the circumference of a rectangle if the length is 15 ft. and the width is 8 ft.

Solution

$C = 2L + 2W$

$= 2 \times 15 + 2 \times 8$

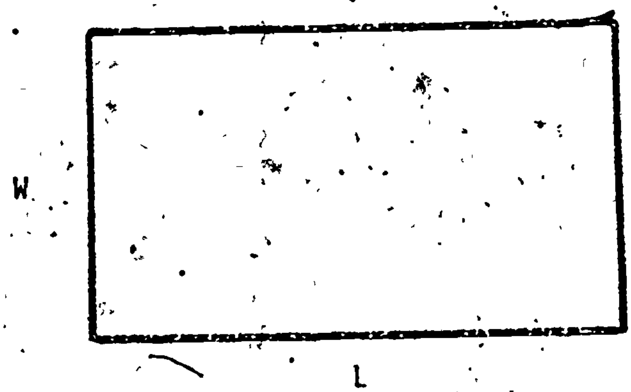
$= 30 + 16$

$= 46$ ft.

C = circumference

L = length

W = width



Exercise: Find the circumference of a rectangle with the dimensions of:

1. L = 60 ft. W = 45 ft. Ans. ________
2. L = 45 ft. W = 30 ft. Ans. ________
3. L = 63 ft. W = 6 ft. Ans. ________
4. L = 40 ft. W = 12 ft. Ans. ________

Triangles

The circumference of a triangle is the sum of the three sides of the triangle.

The answer has linear unit values (feet, yds, meters, etc.)

Formula

$C = a + b + c$

Example: Find the circumference of a triangle

Side a = 20 ft., Side b = 15 ft. and Side c - 25 ft.

C = circumference

a = the length of one side

b = the length of the second side

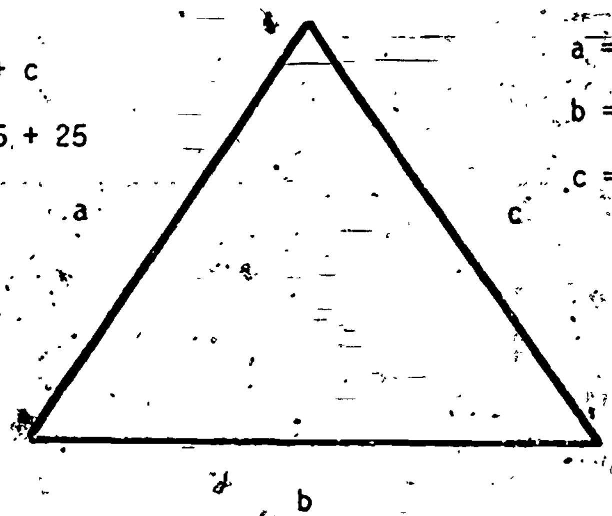
c = the length of the third side

Solution

$C = a + b + c$

$= 20 + 15 + 25$

$= 60$ ft.



Exercise: Find the circumference of a triangle with dimensions:

	a	b	c	
1.	5 ft.	7 ft.	8.6 ft.	Ans.______
2.	10 ft.	14 ft.	17.2 ft.	Ans.______
3.	12 ft.	19 ft.	22.5 ft.	Ans.______
4.	45 ft.	40 ft.	60.2 ft.	Ans.______

Circle

The circumference of a circle is the perimeter of the circular figure. The answer has linear unit values (feet, yds. meters, etc.)

Formula

$C = 2 \times \pi \times R$ or $C = \pi \times D$

Example: Find the circumference of a circle with a diameter of 25 ft.

Solution

$C = \pi \times D$

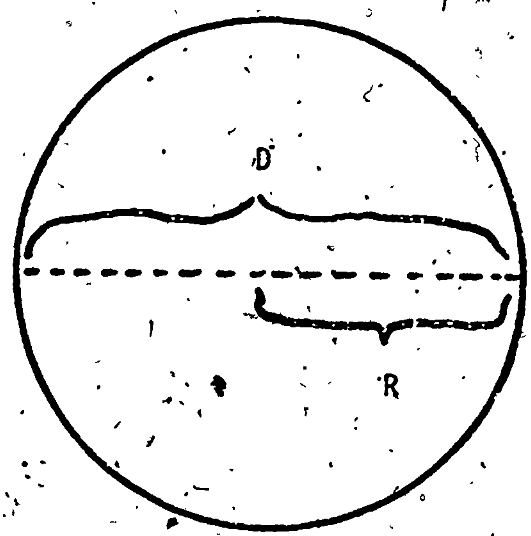
$= 3.14 \times 25$

$= 78.5$ ft.

C = circumference

$\pi = 3.14$

D = diameter



Exercise: Find the circumference of a circle with the dimensions of:

1. R = 30 ft. Ans.________
2. R = 75 ft. Ans.________
3. D = 100 ft. Ans.________
4. D = 150 ft. Ans.________

Trapizoid

The circumference of a trapizoid is the sum of all 4 (four) sides of the figure. The answer has linear unit values (feet, yds., meters, etc.)

Formula: $C = a + b + c + d$

Example: Find the circumference of a trapizoid with side a = 30 ft., side b = 20 ft., side c = 10 ft., and side d = 10 ft.

Solution: $C = a + b + c + d$

$= 30 + 20 + 10 + 10$

$= 70$ ft.

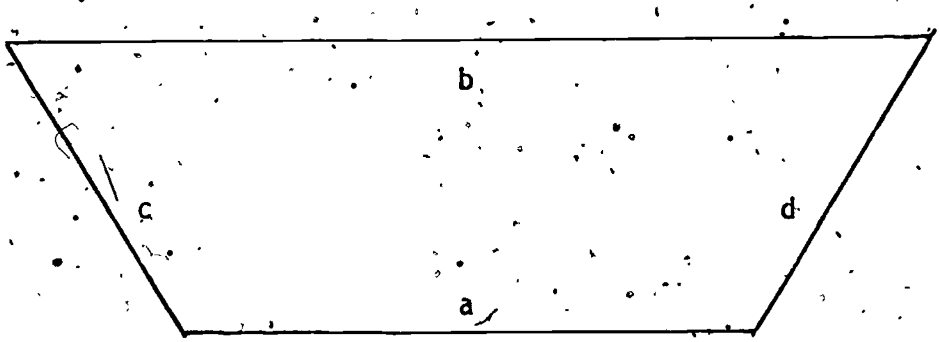
C = circumference

a = length of one side

b = length of opposite side

c = length of one unparallel side

d = length of seccnd unparallel side



Exercise: Find the circumference of a trapizoid with the dimensions of:

	a	b	c	d	
1.	10 ft.	8 ft.	4 ft.	4.5 ft.	1. Ans.______
2.	16 ft.	12 ft.	6 ft.	6 ft.	2. Ans.______
3.	80 ft.	70 ft.	5 ft.	7 ft.	3. Ans.______
4.	100 ft.	85 ft.	3 ft.	4 ft.	4. Ans.______

Module No:	Module Title: Basic Mathematics
	Submodule Title: Circumferences
Approx. Time: ½ hour	EVALUATION

Objectives:

The learner will demonstrate the ability to determine correctly the answers to 5 out of 7 problems related to the circumferences of:

1. Rectangles
2. Triangles
3. Circles
4. Trapizoids

1. What is the circumference of a rectangle that has the dimension of length = 60 ft. and width = 20 ft.

   a. 1200 ft.

   b. 160 ft.

   c. 80 ft.

   d. 120 ft.^{2}

2. What is the circumference of a rectangle where the length is 600 ft. and the width is 500 ft.

   a. 300000 ft.

   b. 2200 ft.

   c. 100 ft.

   d. 80 ft.

3. What is the circumference of a triangle that has the dimensions 40 ft., 44.7 ft., and 60 ft.

   a. 100 ft.

   b. 144.7 ft.

   c. 144.7 ft.^{2}

   d. 88.7 ft.

4. What is the circumference of a triangle that has the dimensions 100 ft., 120 ft., 156.2 ft.

   a. 1200 ft.

   b. 276.2 ft.

   c. 376.2 ft.

   d. 200 ft.

5. What is the circumference of a circle with a radius of 100 ft.

   a. 200 ft.

   b. 314 ft.

   c. 628 ft.

   d. 3140 ft.^{2}

6. What is the circumference of a circle with a diameter of 150 ft.

   a. 1099 ft.

   b. 70650 ft.^{2}

   c. 300 ft.

   d. 471 ft.

7. Find the circumference of a trapizoid with the dimensions of a = 500 ft., b = 490, c = 7 ft., d = 7 ft.

   a. 990 ft.

   b. 1004 ft.

   c. 450 ft.

   d. 554 ft.

Module No:	Topic: Rectangles, Triangles, Circles, Trapizoids

Instructor Notes:	Instructor Outline:
1. Handout	1. Give 7 evaluation problems
Answers	
1. b	
2. b	
3. b	
4. c	
5. c	
6. d	
7. d	

Module No:	Module Title: Basic Mathematics
	Submodule Title: Areas
Approx. Time: 1 hr.	Topic: Rectangles/squares

Objectives:

The learner will demonstrate the ability to determine the area of rectangles and squares.

Instructional Aids:

Handout

AV (Overhead transparancy)

Instructional Approach:

Discussion
Demonstration
Exercise

References:

Workbook, Basic Mathematics and Wastewater Processing Calculations, N. Y. Dept. of Env. Conservation

College Arithmetic, 2nd Edition, W. I. Layton, Wiley & Sons

Class Assignments:

Given 8 exercise problems. 4 rectangles, 4 squares

Module No:	Topic: Rectangles/Squares

Instructor Notes:	Instructor Outline:
1. Handout a. Emphasis that linear measurements have to be in the same unit values i.e. ft. or inches or yds. or meters etc.	1. Discuss/demonstrate how one calculates the area of a rectangle using the formula A = L x W A = Area L = Length W = Width
2. Handout a. Emphasis that linear measurements have to be in the same unit values i.e. ft. or inches or yds. or meters etc.	2. Discuss/demonstrate how one calculates the area of a square using the formula $A = (L)^2$ A = Area L = Length or side
3. Handout	3. Give 8 problems 4 - rectangles 4 - squares

1. Rectangles

A rectangle is a 4-sided geometric figure whose length is different from its width in measurement.

<u>Formula</u>

The area of a rectangle is equal to length x width. $A = L \times W$.

<u>Example</u>

Find the area of a rectangle with the length equal to 45 ft. and width equal to 10 ft.

<u>Solution</u>

$A = L \times W$

$= 45 \text{ ft.} \times 10 \text{ ft.}$

$= 450 \text{ sq. ft.}$

2. Squares

A square is a special rectangle whose length is equal to its width.

<u>Formula</u>

The area of a square is equal to the square of the side.

$A = (L)^2$

<u>Example</u>

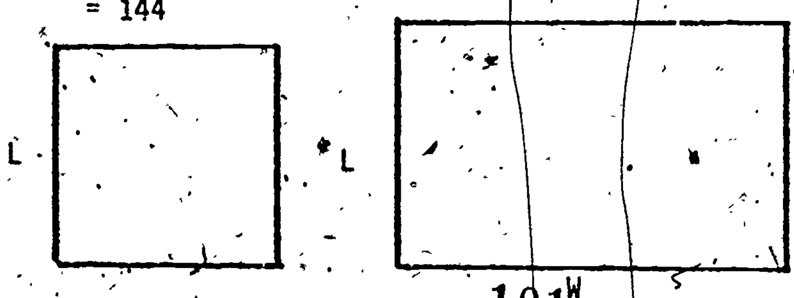
Find the area of a square whose side is equal to 12 ft.

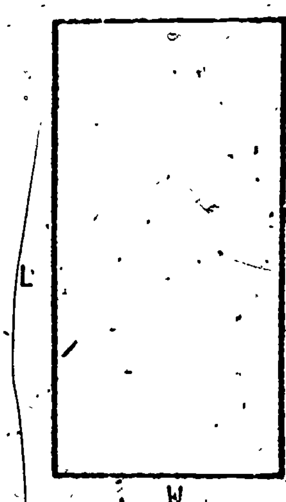
<u>Solution</u>

$A = (L)^2$

$= (12)^2$

$= 144$





Exercise I

Find the area of a rectangle whose dimensions are

	Length	Width		
1.	60 ft.	20 ft.	1.	Ans.______
2.	45 ft.	40 ft.	2.	Ans.______
3.	72 yds.	12 yds.	3.	Ans.______
4.	110 ft.	64 yds.	4.	Ans.______

Exercise II

Find the area of a square whose side dimension is

	Side		
1.	15 ft.	1.	Ans.______
2.	26 ft.	2.	Ans.______
3.	4 yds.	3.	Ans.______
4.	185 in.	4.	Ans.______

Module No:	Module Title: Basic Mathematics
	Submodule Title: Areas
Approx. Time: 1 hr.	Topic: Triangles

Objectives:

The learner will demonstrate the ability to determine the area of triangles and trapizoids.

Instructional Aids:

Handout

AV (Overhead transparahcy)

Instructional Approach:

Discussion
Demonstration
Exercise

References:

Workbook, Basic Mathematics and Wastewater Processing Calculations, N. Y. Dept. of Env. Conservation

College Arithmetic, 2nd Edition, W. I. Layton, Wiley & Sons

Class Assignments:

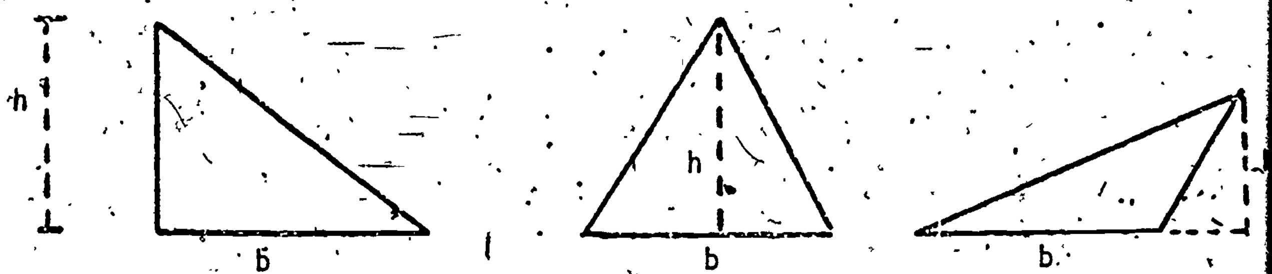
Given 6 exercise problems to be solved.

Module No:	Topic: Triangles

Instructor Notes:	Instructor Outline:
1. Handout a. Emphasis that linear measurements have to be in the same unit values i.e. ft. or inches or yds. or meters etc.	1. Discuss/demonstrate how one calculates the area of a triangle using the formula $A = \frac{1}{2} b \times h$ A = Area b = base h = height
2. Handout	2. Give 4 problems

Triangle

A triangle is a three (3) sided figure. To calculate the area of a triangl one must know the length of one side (known as the base) and the vertical distance (height) from the base to the opposite corner.



Formula

Area of a triangle is equal to ½ x base x height. A = ½ b x h

Example

Find the area of a triangle whose base is 20 ft. and the height is 15 ft.

Solution

$A = \frac{1}{2} \times b \times h$

$= \frac{1}{2} \times 20 \times 15$

$= 150$ sq. ft.

Exercise

Find the area of a triangle whose dimensions are

1. b = 60 ft. h = 20 ft. 1. Ans.________
2. b = 45 ft. h = 40 ft. 2. Ans.________
3. b = 72 yds. h = 12 yds. 3. Ans.________
4. b = 64 yds. h = 110 ft. 4. Ans.________

Module No:	Module Title: Basic Mathematics
	Submodule Title: Areas
Approx. Time: 1 hr.	Topic: Circle

Objectives:

The learner will demonstrate the ability to determine the area of circles.

Instructional Aids:

Handout

AV (Overhead transparancy)

Instructional Approach:

Discussion
Demonstration
Exercise

References:

Workbook, Basic Mathematics and Wastewater Processing Calculations, N. Y. Dept. of Env. Conservation

College Arithmetic, 2nd Edition, W. I. Layton, Wiley & Sons

Class Assignments:

Give 4 exercise problems to be solved

Module No:	Topic: Circle

Instructor Notes:	Instructor Outline:
1. Handout a. Emphasis that linear measurements have to be in the same unit.	1. Discuss/demonstrate how one calculates the area of a circle using the formula $A = \pi R^2$ A = Area π = Pi (3.14) R = Radius of the circle
2. Handout	2. Give 4 problems 2 - radius 2 - diameter

Circle

A circle is a curved line where every point is equidistant from a point within called the center. A circle has major identifying key words.

Radius: Is a line drawn from the center to the outer edge.

Diameter: A straight line drawn from any point on the outer edge through the center to the outer edge on the opposite side.

A diameter is twice the length the radius in retrospect, the radius is half of the diameter.

Formula

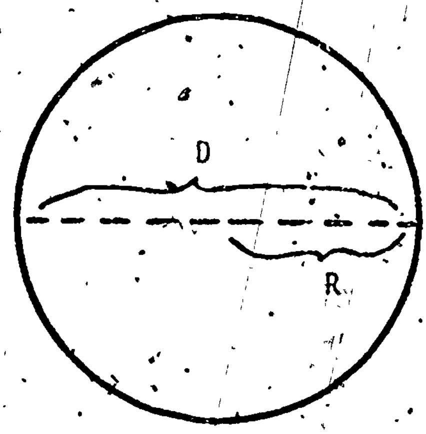
Area of a circle is calculated using either of the three formulas:

1. $A = \pi \times R^2$
2. $A = \dfrac{\pi \times D^2}{4}$
3. $A = .785 \times D^2$

R = radius

D = diameter

$\pi = 3.14$



Example I

Find the area of a circle with a radius of 65 ft.

Solution

$A = \pi \times R^2$

$= 3.14 \times (65)^2$

$\doteq 13266.5$ sq. ft.

Example II

Find the area of a circle with a diameter of 75 ft.

Solution

$A = .785 \times D^2$

$= .785 \times (75)^2$

$= 4415.6$ sq. ft.

Exercise

Find the area of a circle whose radius is

1. 18 ft. — 1. Ans.__________

2. 100 ft. — 2. Ans.__________

Find the area of a circle whose diameter is

1. 108 ft. — 1. Ans.__________

2. 17 yds. 3 ft. — 2. Ans.__________

Module No:	Module Title: Basic Mathematics
	Submodule Title: Areas
Approx. Time: 1 hr.	Topic: Trapizoids

Objectives:

The learner will demonstrate the ability to determine the a·ea of trapizoids

Instructional Aids:

Handout

AV (Overhead transparancy)

Instructional Approach:

Discussion
Demonstration
Exercise

References:

Workbook, Basic Mathematics and Wastewater Processing Calculations, N. Y. Dept. of Env. Conservation

College Arithmetic, 2nd Edition, W. I. Layton, Wiley & Sons

Class Assignments:

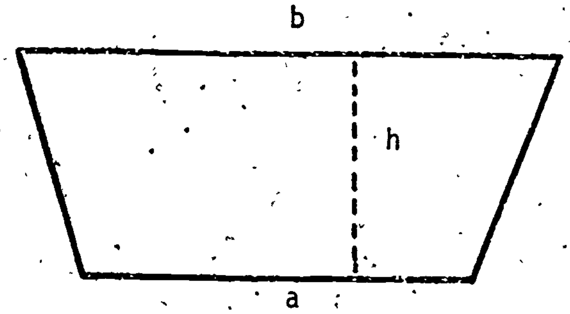
Given 4 exercise problems to be solved

Module No:	Topic: trapizoids

Instructor Notes:	Instructor Outline:
1. Handout a. Emphasis-that linear measurements have to be in the same unit values i.e. ft. or inches or yds. or meters.	1. Discuss/demonstrate how one calculates the area of a trapizoid using the formula $A = \frac{1}{2}(a + b) \times h$ A = Area a = Length of one side b = Length of the opposite parallel side h = height
2. Handout	2. Give 4 problems

Trapizoids

A trapizoid is a 4-sided figure that has two opposite sides parallel but <u>not</u> equal.



Formula

The area of a trapizoid is equal to the average of the sum of the two parallel sides x the height of the figure

$A = \frac{1}{2}(a + b) \times h$

Example

Find the area of a trapizoid with the dimensions of:

Side a = 40 ft. Side b = 36 ft. h = 5 ft.

Solution

$A = \frac{1}{2}(a + b) \times h$

$= \frac{1}{2}(40 + 36) \times 5$

$= 190$ sq. ft.

IT IS IMPORTANT TO NOTE THAT THE ADDITIONS OF a + b HAS TO BE COMPLETED BEFORE MULTIPLYING BY THE HEIGHT AND THEN DIVIDED BY 2.

Exercise

Find the area of a trapizoid with the dimensions of:

1.	a = 10 ft.	b = 15 ft.	h = 5 ft.	1. Ans.________
2.	a = 30 ft.	b = 36 ft.	h = 3 ft.	2. Ans.________
3.	a = 480 ft.	b = 500 ft.	h = 6 ft.	3. Ans.________
4.	a = 110 ft.	b = 64 yds.	h = 2 yds.	4. Ans.________

Module No:	Module Title: Basic Mathematics
	Submodule Title: Areas
Approx. Time: 1 hour	EVALUATION

Objectives:

The learner will demonstrate the ability to determine correctly the answers to 8 out of 10 problems of areas of geometric figures of:

1. Rectangles/squares
2. Triangles
3. Circles
4. Trapizoids

1. A triangle has as its base 8 1/3 ft. and its height 3 3/5 ft. Compute its area.

   a. 15 sq. ft.

   b. 18 sq. ft.

   c. 25 sq. ft.

   d. 30 sq. ft.

2. A lagoon has a length of 550 ft. and a width of 400 ft. What is the surface area of the lagoon.

   a. 225,000

   b. 220,000

   c. 69,080

   d. 1,220,000

3. An 8 inch water main has a cross-sectional area of

   a. 200.96 sq. inches

   b. 50.24 sq. inches

   c. 150.24 sq. inches

4. The cross-sectional area of an 8 inch pipe is how many times as great as the cross-sectional area of a 4 inch pipe.

a. 2

b. 6

c. 4

d. 8

5. The length of a rectangle is 62 ft. and the width is 30 ft. Find the surface area.

a. 900 sq. ft.

b. 92 sq. ft.

c. 1860 sq. ft.

d. 3844 sq. ft.

6. A circular clarifier has a radius of 48 ft. What is the surface area.

a. 301.44

b. 1808.64

c. 150.72

d. 7234.56

7. A trapizoid has the dimensions of the two opposite sides being (a) 480 ft. and (b) 500 ft. The height of the trapizoid is 5 ft. Calculate the area of the trapizoid.

a. 2450 sq. ft.

b. 4900 sq. ft.

c. 600000 sq. ft.

d. 36,000 sq. ft.

8. A 14 inch water main has an area of:

a. 1.068 sq. ft.

b. 615.44 sq. ft.

c. 153.86 sq. ft.

d. 0.9158 sq. ft.

9. A trickling filter has a diameter of 100 ft. What is the area?

   a. 78.5 sq. ft.

   b. 31400 sq. ft.

   c. 7850 sq. ft.

   d. 2125 sq. ft.

10. A rectangular sedimentation tank has the dimensions of length 101 ft. and 6 inches, and width of 28 ft. 4 inches. Find the surface area of the tank.

   a. 129.83 sq. ft.

   b. 2885.44 sq. ft.

   c. 2875.83 sq. ft.

   d. 2000.65 sq. ft.

Module No:	Topic: Evaluation

Instructor Notes:	Instructor Outline:
1. Handout	1. Give 10 evaluation problems.
Answers	
1. a	
2. b	
3. b	
4. c	
5. c	
6. d	
7. a	
8. a	
9. c	
10. c	

Module No:	Module Title: Basic Mathematics
	Submodule Title: Volumes
Approx. Time: 1 hr.	Topic: Rectangular solids/cubes

Objectives: The learner will demonstrate the ability to determine the volume of rectangular solids and of cubes.

Instructional Aids:

Handout

AV (overhead transparancy)

Instructional Approach:

Discussion
Demonstration
Exercise

References:

Workbook, Basic Mathematics and Wastewater, Processing Calculations, N. Y. Dep of Env. Conservation

College Arithmetic, 2nd Edition, W. I. Layton, Wiley & Sons.

Study Aid Workbook, Mathematics for Wastewater Treatment Plant Operators, California Water Pollution Control Association

Class Assignments:

Given 8 exercise problems to be solved - 4 rectangular solid, 4 cube

Module No:	Topic: Rectangular solids/cubes

Instructor Notes:	Instructor Outline:
1. Handout a. Emphasis that linear measurements have to be in the same unit values i.e. feet or inches, or yds. or meters etc. b. Emphasis that the unit values for volume is in cubic ft. or cubic yds. cubic meters etc.	1. Discuss/demonstrate how one calculates the volume of a rectangular solid using the formula $V = L \times W \times H$ V = Volume L = Length W = Width H = Height or depth 2. Discuss/demonstrate how one calculates the volumes of a cube using the formula $V = (L)^3$ V = Volume L = Length of one side, 3. Give 8 problems 4 - cube 4 - rectangular solids

Rectangular Solids

A three dimensional figure that has six (6) surface sides.

Formula

The volume of a rectangular solid is equal to the length x width x height of the figure

V = L x W x H

Example

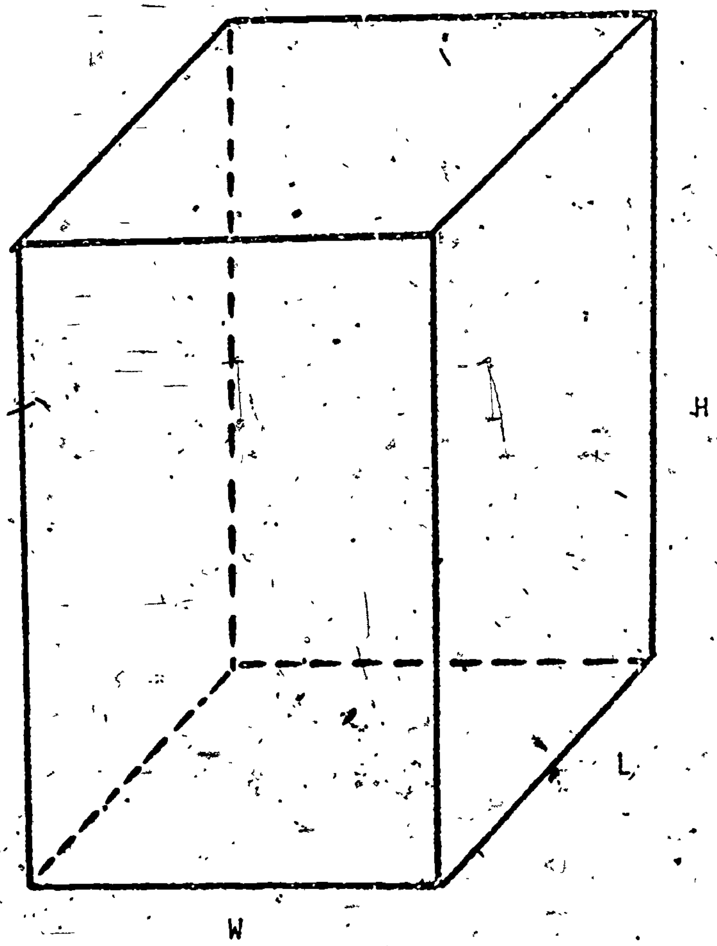
Find the volume of a settling tank whose dimensions is length, 30 ft. width 15 f and height 10 ft.

Solution

V = L x W x H

= 30 x 15 x 10

= 4500 cu. ft.



Cube

A cube is a special rectangular solid where all sides are equal.

Formula

$V = (L)^3$

Example

Find the volume of a settling basin with the dimension of 20 ft.

Solution

$V = (L)^3$

$= (20)^3$

$= 8000$ cu. ft.

Exercise

Find the volume of a settling basin with the dimensions of

1. Length 15 ft.	Width 10 ft.	Height 5 ft.	1.	Ans.______
2. Length 16 in.	Width 6 in.	Height 12 in.	2.	Ans.______
3. Length 200 ft.	Width 150 ft.	Height 5 ft.	3.	Ans.______
4. Length 20 ft.	Width 20 ft.	Height 26 in.	4.	Ans.______

Find the volume of a settling basin with the dimensions of

1. Side 5 ft.	1.	Ans.______
2. Side 10 ft.	2.	Ans.______
3. Side 12 in.	3.	Ans.______
4. Side 8 yds.	4.	Ans.______

Module No:	Module Title: Basic Mathematics
	Submodule Title: Volumes
Approx. Time: 1/2 hr.	Topic: Cylinder

Objectives: The learner will demonstrate the ability to determine the volume of a cylinder

Instructional Aids:

Handout

AV (overhead transparancy)

Instructional Approach:

Discussion
Demonstration
Exercise

References:
Workbook, Basic Mathematics and Wastewater, Processing Calculations, N. Y. Dept. of Env. Conservation

College Arithmetic, 2nd Edition, W. I. Layton, Wiley & Sons

Study Aid Workbook, Mathematics for Wastewater Treatment Plant Operators, California Water Pollution Control Association

Class Assignments:

Given 8 exercise problems to be solved.

Module No:	Topic: Cylinder

Instructor Notes:	Instructor Outline:
I. Handout a. Emphasis that linear measurements have to be in the same unit values i.e. feet or inches, or yds. or meters etc. b. Emphasis that the unit values for volume is in cubic ft. or cubic yds. cubic meters etc.	1. Discuss/demonstrate how one calculates the volume of a cylinder using the formula $V = \pi \times R^2 \times H$ or $V = \frac{\pi D^2}{4} \times H$ $V = .785 \times D^2 \times H$ V = Volume $\pi = 3.14$ R = Radius of circle D = Diameter of circle H = Height or length of cylinder 2. Give 8 exercise problems

Cylinder

A cylinder is a very common figure. Pipes and cans have the form of a cylinder

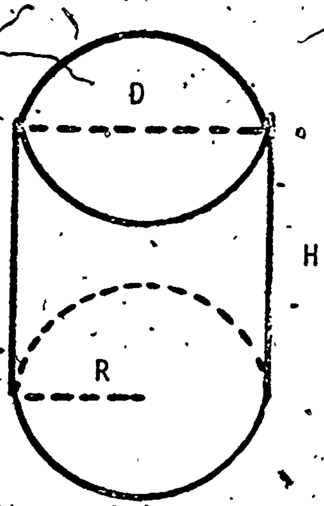
Formula

The volume of a cylinder is equal to area of the base x the height

(REMEMBER THAT THE BASE IS A CIRCLE)

The three formulas that could be used

1. $V = \pi \times R^2 \times H$
2. $V = \frac{\pi \times D^2}{4} \times H$
3. $V = .785 \times D^2 \times H$



(Figure 1)

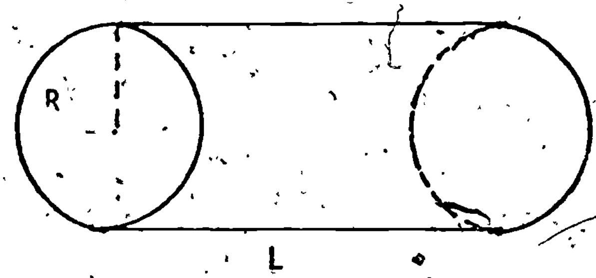
R = Radius

D = Diameter

H = Height

π = 3.14

It should be noted that the position of a cylinder may be vertical, Figure (1) or horizontal, Figure (2)



(Figure 2)

Example 1

Find the volume of a cylindrical tank with a radius of 20 ft. and a height of 45 ft.

Solution

$V = \pi \times R^2 \times H$

$= 3.14 \times (20)^2 \times 45$

$= 56520$ cu. ft.

Example 2

Find the volume of a pipe with a diameter of 12 inches and a length of 20 ft.

Solution

A. 12 inches is converted to feet - 1 ft.

B. Using the formula

$V = .785 \times D^2 \times H$

The H is the letter indicating height, but since the problem states length than substitute L for H. So the formula

$V = .785 \times D^2 \times H$

Is converted to

$V = .785 \times D^2 \times L$

$= .785 \times (1)^2 \times 20$

$= 15.7$ cu. ft.

Exercise 1

Find the volume of a circular tank with the dimensions of

1. Radius 40 ft.	Height 15 ft.	1.	Ans.__________
2. Radius 62	Height 120 ft.	2.	Ans.__________
3. Diameter 124 ft.	Height 60 ft.	3.	Ans.__________
4. Diameter 80 ft.	Height 30 ft.	4.	Ans.__________

Exercise 2

Find the volume ($ft.^3$) of a water main (pipe) with the dimension

1. Diameter 8 inches	Length 2000 ft.	1.	Ans.__________
2. Diameter 14 inches	Length 400 ft.	2.	Ans.__________
3. Diameter 18 inches	Length 12 ft.	3.	Ans.__________
4. Diameter 6 inches	Length 20 ft.	4.	Ans.__________

Module No:	Module Title: Basic Mathematics
	Submodule Title: Volumes
Approx. Time: 1/2 hr.	Topic: Prisms

Objectives: The learner will demonstrate the ability to determine the volume of a prism.

Instructional Aids:

Handout

AV (overhead transparancy)

Instructional Approach:

Discussion
Demonstration
Exercise

References:

Workbook, Basic Mathematics and Wastewater, Processing Calculations, N. Y. Dept. of Env. Conservation

College Arithmetic, 2nd Edition, W. I. Layton, Wiley & Sons

Study Aid Workbook, Mathematics for Wastewater Treatment Plant Operators, California Water Pollution Control Association

Class Assignments:

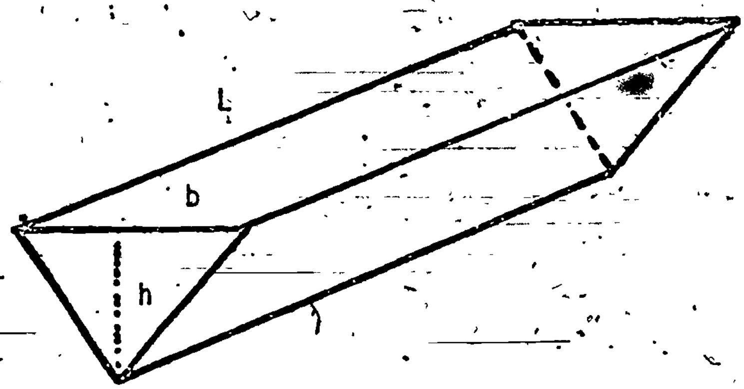
Give 4 exercise problems to be solved

Module No:	Topic: Prism

Instructor Notes:	Instructor Outline:
1. Handout a. Emphasis that linear measurements have to be in the same unit values i.e. feet or inches, or yds. or meters etc. b. Emphasis that the unit values for volume is in cubic ft. or cubic yds. cubic meters etc.	1. Discuss/demonstrate how one calculates the volume of a prism V = 1/2 x b x h x L V = Volume b = Base of triangle h = Height of triangle L = Height or length of the prism 2. Give 4 problems.

Prism

The best way to describe a prism is to visualize the figure.



Formula

The volume of a cylinder is equal to area of the triangle x the length

$V = \frac{1}{2} \times b \times h \times L$

Exercise

Calculate the volume of a prism with the dimensions

1. b = 10 ft.	h = 4 ft.	L = 15 ft.	1.	Ans. ______
2. b = 45 ft.	h = 40 ft.	L = 2 ft.	2.	Ans. ______
3. b = 25 ft.	h = 10 ft.	L = 5 ft.	3.	Ans. ______
4. b = 65 ft.	h = 2 ft.	L = 40 ft.	4.	Ans. ______

Module No:	Module Title: Basic Mathematics
	Submodule Title: Volumes
Approx. Time: 1/2 hr.	Topic: Trapizoidal solids

Objectives: The learner will demonstrate the ability to determine the volume of trapizoidal solids.

Instructional Aids:

Handout

AV (overhead transparancy)

Instructional Approach:

Discussion
Demonstration
Exercise

References:

Workbook, Basic Mathematics and Wastewater, Processing Calculations, N. Y. Dept. of Env. Conservation

College Arithmetic, 2nd Edition, W. I. Layton, Wiley & Sons.

Study Aid Workbook, Mathematics for Wastewater Treatment Plant Operators, California Water Pollution Control Association

Class Assignments:

Given 4 exercise problems to be solved.

Module No:	Topic: Trapizoidal Solids

Instructor Notes:

1. Handout
   a. Emphasis that linear measurements have to be in the same unit values i.e. feet or inches, or yds. or meters etc.
   b. Emphasis that the unit values for volume is in cubic ft. or cubic yds. cubic meters etc.
   c. Note that trapizoidal solids usually is the geometric figure of a lagoon.
   d. Explain that $A_1 = L_1 x W_1$

      L_1 = Surface length

      W_1 = Surface width

      and that

      $A_2 = L_2 x W_2$

      L_1 = Length of base

      W_1 = Width of base

Instructor Outline:

1. Discuss/demonstrate how one calculates the volume of a trapizoidal solid using the formula

   $V = 1/2 (A_1 + A_2) \times H$

   V = Volume

   A_1 = Area of the surface (L x W)

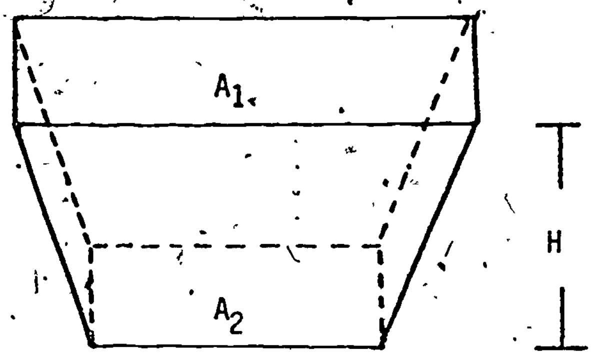
   A_2 = Area of the base

   H = Height or depth

2. Give 4 problems

Trapizoidal Solid

A trapizoidal solid is a geometric figure where two opposite and parallel surfaces are not equal in area.



Formula

The volume of a trapizoidal solid is equal to the average of the two parallel surfaces x the height (depth) of the solid.

$V = 1/2\ (A_1 + A_2) \times H$

A_1 = Area of the surface $L_1 \times W_1$

Where L_1 and W_1 is the length of the surface

And

A_2 = Area of the base $L_2 \times W_2$

Where L_2 and W_2 is the length and width of the base

And H is the height

This geometric figure is usually the figure of a lagoon.

Example

The surface dimensions of a lagoon is 400 ft., length and 300 ft. width. The bottom (base) dimensions are length 390 ft. and width 290 ft. The depth of the lagoon is 5 ft. Calculate the volume of the lagoon.

Solution

$V = 1/2\ (A_1 + A_2) \times H$

$= 1/2\ (120000 + 113100) \times 5$

$= 582750$ cu. ft.

IT IS IMPORTANT TO NOTE THAT THE ADDITION OF $A_1 + A_2$ HAS TO BE COMPLETED BEFORE MULTIPLYING BY THE HEIGHT AND THEN DIVIDED BY 2.

Exercise

Find the volume of a lagoon with the dimensions of:

	Surface Length (L_1)	Surface Width (W_1)	Base Length (L_2)	Base Width (W_2)	H	Ans.
1.	600 ft.	300 ft.	580 ft.	290 ft.	6 ft.	______
2.	500 ft.	400 ft.	475 ft.	385 ft.	4 ft.	______
3.	18 ft.	12 ft.	17 ft.	10 ft.	5 ft.	______
4.	40 ft.	35 ft.	38 ft.	32 ft.	3 ft.	______

Module No:	Module Title: Basic Mathematics
	Submodule Title: Volumes
Approx. Time: 1 hr.	Topic: Pyramid

Objectives: The learner will demonstrate the ability to determine the volume of pyramids with:

1. Triangular base
2. Rectangular base
3. Circular base (cone)

Instructional Aids:

Handout

AV (Overhead transparancy)

Instructional Approach:

Discussion
Demonstration
Exercise

References:

Workbook, Basic Mathematics and Wastewater, Processing Calculations, N. Y. Dept. of Env. Conservation

College Arithmetic, 2nd Edition, W. I. Layton, Wiley & Sons.

Study Aid Workbook, Mathematics for Wastewater Treatment Plant Operators, California Water Pollution Control Association.

Class Assignments:

Given 12 exercise problems to be solved
4 - Triangular base, 4 - Rectangular base, 4 - Circular base (cone)

Module No:	Topic: Pyramid

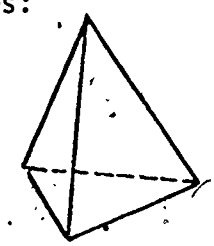
Instructor Notes:	Instructor Outline:
1. Handout a. Emphasis that linear measurements have to be in the same unit values i.e. feet or inches, or yds. or meters etc. b. Emphasis that the unit values for volume is in cubic ft. or cubic yds. cubic meters etc.	1. Discuss/demonstrate how one calculates the volume of a pyramid with a triangular base using the formula $V = 1/6 \times b \times h \times H$ V = Volume b = Base of triangle h = Height of triangle H = Height of pyramid
2. Handout a. Emphasis that linear measurements have to be in the same unit values i.e. feet or inches, or yds. or meters etc. b. Emphasis that the unit values for volume is in cubic ft. or cubic yds. cubic meters etc.	2. Discuss/demonstrate how one calculates the volume of a pyramid with a rectangular base use the formula $V = 1/3\ L \times W \times H$ V = Volume L = Length of rectangle W = Width of rectangle H = Height of pyramid
3. Handout a. Emphasis that linear measurements have to be in the same unit values i.e. feet or inches, or yds. or meters etc. B. Emphasis that the unit values for volume is in cubic ft. or cubic yds. cubic meters etc.	3. Discuss/demonstrate how one calculates the volume of a pyramid with a circular base using the formula $V = 1/3\ \pi R^2 \times H$ $V = 1/12\ \pi D^2 \times H$ V = Volume π = 3.14 R = Radius of Circle D = Diameter of circle

Module No:	Topic: Pyramids
Instructor Notes:	**Instructor Outline:**
	4. Give 12 problems 4 - Triangular base 4 - Rectangular base 4 - Circular base

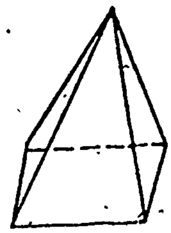
Pyramids

Pyramids come in three basic base shapes:

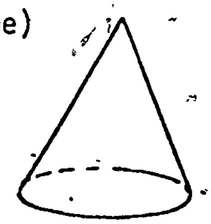
1. The Triangular Base



2. The Square or rectangular Base



3. The Circular Base (cone)



Formula

The formula to calculate the volume of a pyramid is:

V = 1/3 x Height x Area of the base

The formula for a triangular based pyramid is:

V = 1/3 x H x 1/2 x b x h or V = 1/6 x b x h x H

b = Length of side of triangle

h = Height of triangle

H = Height of pyramid

Example I

A sludge hopper has the shape of a triangular based pyramid with the dimensions

b = 30 ft. h = 20 ft. Height = 2 ft.

Solution I

V = 1/6 x b x h x H

= 1/6 x 30 x 20 x 2

= 200 cu. ft.

Formula

The formula for a rectangular based pyramid is:

$V = 1/3 \times H \times L \times W$

L = Length of rectangle

W = Width of rectangle

H = Height of pyramid

Example II

Find the volume of a sludge hopper that has the shape of a rectangular based pyramid with the dimensions of:

L = 60 ft. W = 50 ft. Height 3 ft.

Solution II

$V = 1/3 \times L \times W \times H$

$= 1/3 \times 60 \times 50 \times 3$

$= 3000$ cu. ft.

Formula

The formula for a circular based pyramid (cone) is .

$V = 1/3 \times \pi \times R^2 \times H$

$\pi = 3.14$

R = Radius of circle

H = Height

Example III

Find the volume of a cone that has the dimensions of:

R = 50 ft. H = 5 ft.

$V = 1/3 \times \pi \times R^2 \times 5$

$= 1/3 \times 3.14 \times (50)^2 \times 5$

$= 13083.33$ cu. ft.

Exercise

Find the volume of a settling basin that has a figure of a triangular based pyramid with the dimensions of:

1. b = 5 ft.	h = 3 ft.	H = 4 ft.	1.	Ans.__________
2. b = 30 ft.	h = 20 ft.	H = 7 ft.	2.	Ans.__________
3. b = 10 ft.	h = 12 ft.	H = 11 ft.	3.	Ans.__________
4. b = 35 ft.	h = 30 ft.	H = 15 ft.	4.	Ans.__________

Find the volume of a settling basin that has a figure of a rectangular based pyramid with the dimensions of:

1. L = 10 ft.	W = 4 ft.	H = 15 ft.	1.	Ans.__________
2. L = 1 ft.	W = 6 in.	H = 28 in.	2.	Ans.__________
3. L = 60 ft.	W = 20 ft.	H = 2 ft.	3.	Ans.__________
4. L = 40 ft.	W = 35 ft.	H = 1 ft.	4.	Ans.__________

Find the volume of a cone with the dimensions of:

1. R = 15 ft.	H = 12 ft.	1.	Ans.__________
2. R = 7 ft.	H = 36 in.	2.	Ans.__________
3. D = 30 ft.	H = 12 ft.	3.	Ans.__________
4. D = 36 ft.	H = 2 ft.	4.	Ans.__________

Module No:	Module Title: Basic Mathematics
	Submodule Title: Volumes
Approx. Time: ½ hr.	Topic: Sphere

Objectives:

The learner will demonstrate the ability to determine the volume of a sphere.

Instructional Aids:

Handout

AV (overhead transparancy)

Instructional Approach:

Discussion
Demonstration
Exercise

References:

Workbook, Basic Mathematics and Wastewater, Processing Calculations, N. Y. Dept. of Env. Conservation.

Study Aid Workbook, Mathematics for Wastewater Treatment Plant Operators, California Water Pollution Control Association.

Class Assignments:

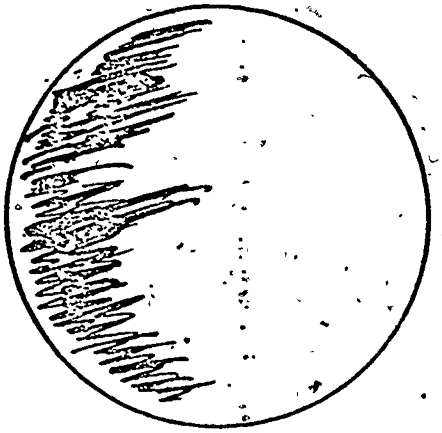
Given 4 exercise examples

Module No:	Topic: Sphere

Instructor Notes:	Instructor Outline:
1. Handout a. Emphasis that $R^3 = R \times R \times R$ and Not $3 \times R$ b. Emphasis that the unit values for volume is cubic ft. or cubic yds. cubic meters etc.	1. Discuss/demonstrate how one calculates the volume of a cylinder using the formula: $V = 4/3 \times \pi \times R^3$ V = Volume of sphere $\pi = 3.14$ R = Radius of sphere Give 4 exercise problems

Spheres

A sphere is a solid figure included by a surface where every point of which is equi-distance from a point within (the center).



Formula

The formula to calculate the volume of a sphere is

$V = \frac{4}{3} \times \pi \times R^3$

V = Volume

π = 3.14

R = Radius of sphere

Example

A sphere has a radius of 30 ft. Calculate the volume of the sphere.

Solution

The formula of the sphere is:

$V = \frac{4}{3} \times \pi \times R^3$

$= \frac{4}{3} \times 3.14 \times (30)^3$

$= \frac{4}{3} \times 3.14 \times 30 \times 30 \times 30$

= 113040 cu. ft.

Exercise

Calculate the volume of the sphere when:

R = Radius

D = Diameter

1. R = 50 ft.	1. Ans.__________
2. R = 25 ft.	2. Ans.__________
3. D = 60 ft.	3. Ans.__________
4. D = 100 ft.	4. Ans.__________

Module No:	Module Title: Basic Mathematics
	Submodule Title: Volumes
Approx. Time: 1 hr.	Topic: Combination of 2 geometric figures

Objectives:

The learner will demonstrate the ability to determine the volume of geometric figures composed of 2 basic solid figures.

Instructional Aids:

Handout

AV (overhead transparancy)

Instructional Approach:

Discussion
Demonstration
Exercise

References:

Workbook, Basic Mathematics and Wastewater, Processing Calculations, N. Y. Dept. of Env. Conservation

College Arithmetic, 2nd Edition, W. I. Layton, Wiley & Sons.

Study Aid Workbook, Mathematics for Wastewater Treatment Plant Operators, California Water Pollution Control Association

Class Assignments:

Given 3 exercise problems to be solved.

Module No:	Topic: Combination of 2 geometric figures

Instructor Notes:	Instructor Outline:
1. Handout	1. Discuss/demonstrate how one calculates the volume of a unit that is composed of two figures.
2. Typical units composed of two figures are: 1. Cylinder and cone 2. Rectangular solid and rectangular based pyramid. 3. Cylinder and ½ sphere. 4. Rectangular solid and prism. 5. Rectangular solid and trapizoid.	2. Give 3 exercise problems.

Combination of 2 geometric figures.

Most units used in treatment plants are composed of a combination of two figures.

One must first determine what basic figures compose the unit.

Example

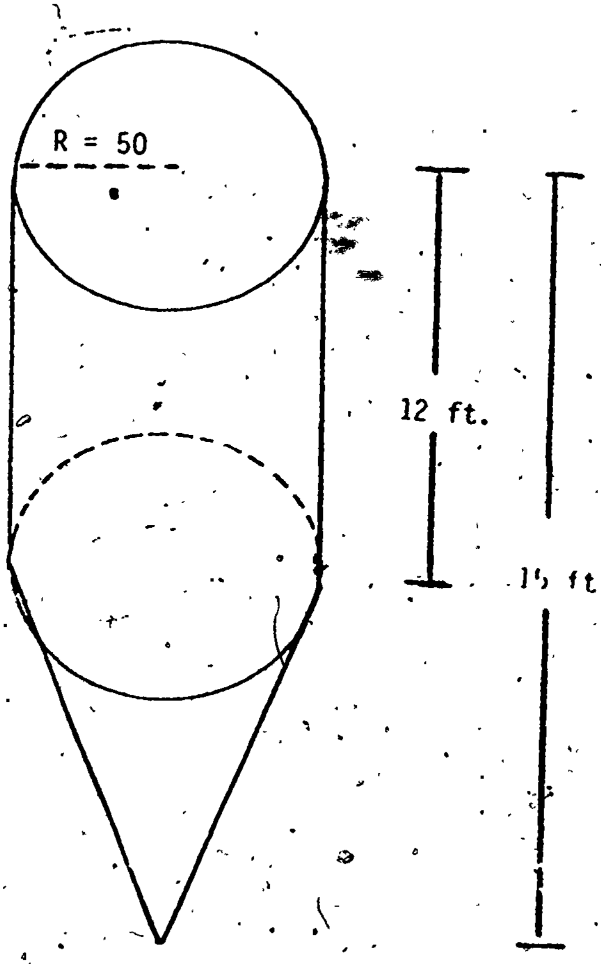
A clarifier (see sketch) has the dimensions of: Radius 50 ft., the total weight is 15 ft. and the height of the vertical wall is 12 ft. Calculate the volume of the clarifier. Ans. in cubic ft.

Solution

The volume of the clarifier is composed of two volumes

1. Volume of the cylinder

2. Volume of the cone



Formula

Total volume = V cyl. x V cone

V cyl. = $\pi \times R^2 \times H$

$= 3.14 \times (50)^2 \times 12$

= 94200 cu. ft.

V Cone = $1/3\ \pi \times R^2 \times H$

$= 1/3 \times 3.24 \times (50)^2 \times (15 - 12)$

$= 1/3 \times 3.14 \times (50)^2 \times 3$

= 7850 cu. ft.

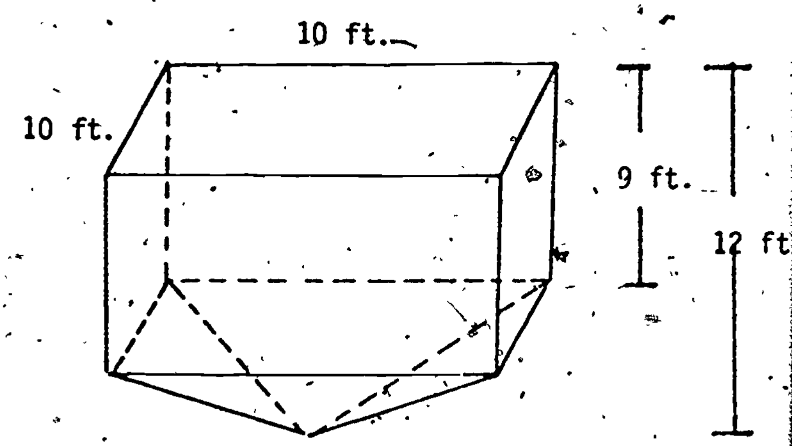
Total volume = V cyl. + V Cone

= 94200 + 7850

= 102050 cu. ft.

Exercise

1. Find the volume of the figure with the dimensions (see sketch)



Solution

T Vol = V Rect. + V of prism

$= L \times W + H_R + 1/3 \times L \times W \times H_p$

$= 10 \times 10 \times 9 + 1/3 \times 40 \times 10 \times 3$

$= 900 + 100$

= 1000 cu. ft.

2. Find the volume of a figure with the dimension (see sketch)

Solution

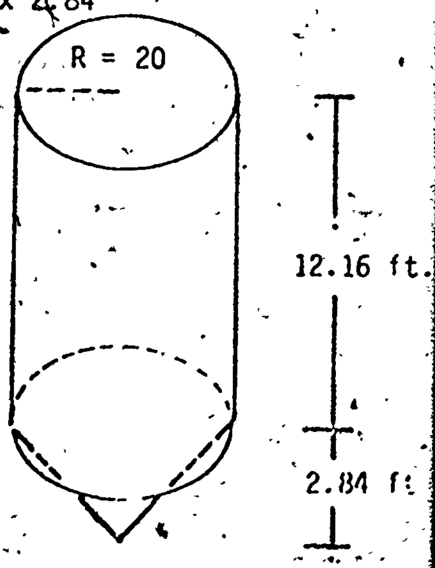
T Vol = V cyl + V cone

$= \pi \cdot R^2 \times H\ cyl + 1/3\ \pi\ R^2 \times H\ cone$

$= 3.14 \times (20)^2 \times 12.16 + 1/3 \times 3.14 \times (20)^2 \times 2.84$

$= 15272.96 + 1189.01$

= 16461.97 cu. ft.



3. Calculate the volume of a settling basin with the dimensions of (see sketch

Solution

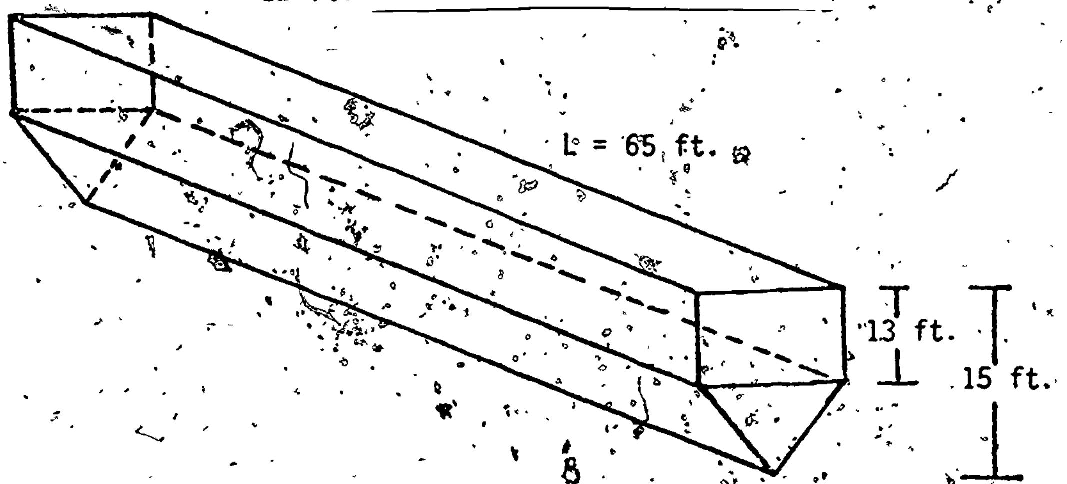
TV = V Rect. + V of prism

= L x W x H + 1/6 x b x h x L

= 65 x 12 x 13 + ~~1/6~~ x 12 x 2 x 65

= 10140 + 780

= 10920 cu. ft.



Module No:	Module Title: Basic Mathematics
	Submodule Title: Volumes
Approx. Time: 1 hour	EVALUATION

Objectives:

The learner will demonstrate the ability to determine correctly the answers to 8 out of 10 problems related to one or more solid geometric figures related to rectangular solids or cylinders or pyramids or sphere and prism and trapizoidal solids.

1. A rectangular settling tank is 100 ft. long, 30 ft. wide and 9 ft. deep. What is the volume of the tank?

   a. 20,000 cu. ft.

   b. 27,000 cu. ft.

   c. 30,000 cu. ft.

   d. 2700 cu. ft.

2. A cylinder tank with a diameter of 10 ft. is filled to a depth of 12 ft. with water. How many cu. ft. of water does it contain.

   a. 376.8 cu. ft.

   b. 942.0 cu. ft.

   c. 3768.0 cu. ft.

   d. 94.20 cu. ft.

3. An 8" water main 5200 feet long is attached to the existing water main. How many gallons of water will be needed to fill the main.

   a. 7816540.1 gallons

   b. 54281.53 gallons

   c. 1954135. gallons

   d. 13570.38 gallons

4. A sphere has a radius of 20 ft. How many gallons of water does the sphere hold.

   a. 250530.13 gallons

   b. 237220.70 gallons

   c. 18840.00 gallons

   d. 33493.33 gallons

5. A circular settling tank has a diameter of 110 ft. The depth of water is 12 ft. Calculate the volume of water in gallons the tank holds.

   a. 113982.00 gallons

   b. 734760.03 gallons

   c. 852585.36 gallons

   d. 3410341.4 gallons

6. A lagoon has the surface dimensions of length 850 ft. and width 400 ft. The bottom dimensions are 840 ft. long and 390 ft. wide. The depth of water is 5 ft. How many gallons of wastewater does the lagoon hold.

   a. 3550500.0 gallons

   b. 26557740.0 gallons

   c. 12,484,120 gallons

   d. 12,716,000.0 gallons

7. Find the volume of a cone with a radius of 12 ft. and a height of 4 ft.

   a. 602.88 cu. ft.

   b. 1808.64 cu. ft.

   c. 3382.16 cu. ft.

   d. 452.16 cu. ft.

8. A circular lift station has a diameter of 8.5 ft. and the water level reaches a depth of 16 ft. before the pump starts. If the depth of the water left in lift station after pumping is 1 ft. how many gallons was pumped.

a. 907.46 gallons

b. 6787.80 gallons

c. 25454.25 gallons

d. 6363.56 gallons

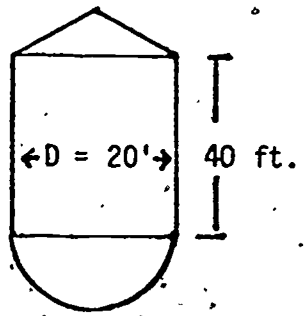
9. A water tower has the dimensions (see sketch). How many gallons of water does it hold.

a. 39145.33 gallons

b. 133889.6 gallons

c. 109606.93 gallons

d. 102756.5 gallons



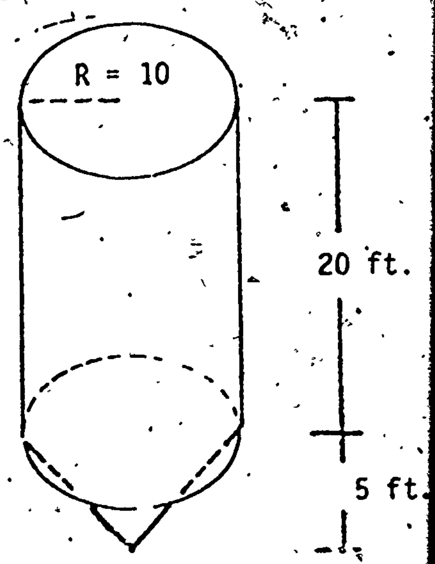
10. A circular settling basin has the dimensions and bottom shape shown in the sketch. Find the volume of water in the settling basin.

a. 10717.87 gallons

b. 58918.0 gallons

c. 50888.93 gallons

d. 14679.5 gallons



Module No:	Topic: Evaluation

Instructor Notes:	Instructor Outline:
1. Handout Answers 1. b 2. b 3. d 4. a 5. c 6. c 7. a 8. d 9. c 10. c	1. Give 10 evaluation problems.

Module No:	Module Title: Basic Mathematics
	Submodule Title: Detention Time
Approx. Time: 1 hour	Topic: Detention Time

Objectives:

The learner will demonstrate the ability to determine the detention time in water and wastewater units.

Instructional Aids:

Handout

AV (overhead transparancy).

Instructional Approach:

Discussion
Demonstration
Exercise

References:

Workbook, Basic Mathematics and Wastewater, Processing Calculations, N. Y. Dept. of Env. Conservation

Study Aid Workbook, Mathematics for Wastewater Treatment Plant Operators, California Water Pollution Control Association.

Class Assignments:

1. Read handout
2. Given 10 exercise problems to be solved

Module No:	Topic: Detention Time

Instructor Notes:	Instructor Outline:
1. Handout	1. Discuss/demonstrate detention time.
2. Important that the volume of tank and flow rate be in the same unit value.	A. The formula to use is $DT = \frac{V}{Q}$ V = Volume of tank; Q = Flow rate; DT = Detention time
Ex.	2. Give 10 exercise problems
a. V = Gallons Q = Gallons per unit time Ex. GPS, GPM, GPH, GPD	
or	
b. V = Cubic feet Q = Cubic feet per unit time Ex. CPS, CPM, CPH, CPD	
c. Indicate that normal procedure for reporting detention time	
1. Lagoons are in <u>days</u>. Digesters are in <u>days</u>. 2. Grit chambers and small specialty sedimentation units are in <u>seconds</u> or <u>minutes</u>. 3. Clarifiers are in <u>hours</u>.	

Detention Time

Detention time can be defined as

a. The amount of TIME it takes to fill an empty tank, or

b. How long a unit volume of water is held in a tank

Formula

The formula to use in determining the detention time (DT) is

$DT = \frac{V}{Q}$

DT = Detention Time

V = Volume of tank

Q = Flow rate

There are two things to keep in mind when calculating for detention time.

1. The volume of the tank (V) and the flow rate (Q) have to have the same unit values

Example

V = Gallons

and Q in GPS
GPM
GPH or
GPD

or V in Cubic feet

and Q in CFS
CFM
CFH
CFD

2. The value time depends on the type of process.

   a. Lagoon detention times are usually reported in days, therefore Q should be in either GPD or CFD.

   b. Digester detention times are usually reported in days, therefore Q should be in either GPD or CFD.

   c. Grit chamber and small specialty sedimentation units, detention times are usually reported in seconds or minutes.

Therefore Q is either GPS/GPM or CFS/CFM

d. Clarifiers detention times are usually reported in hours, therefore Q should be in GPH or CFH.

REMEMBER

$DT = \frac{V}{Q}$

DT = Detention Time

V = Volume of tank

Q = Flow rate

Example

What is the detention time in a sedimentation unit that has the volume of 20,000 gallons and the flow rate is 10,000 gallons per hour?

Solution

$$DT = \frac{V}{Q}$$

$$= \frac{20,000}{10,000}$$

$$= 2 \text{ hrs.}$$

Example

A circular clarifier has a diameter of 50 ft. and a depth of 16 ft. The flow flowing into the tank at a rate of 33 GPS.

Solution

$$DT = \frac{V}{Q}$$

$V = .785 \times D^2 \times H \times 7.48$ and

$Q = GPS \times 60 \times 60 = GPH$ so

$$DT = \frac{.785 \times D^2 \times H \times 7.48}{GPS \times 60 \times 60}$$

$$= \frac{.785 \times 50 \times 50 \times 16 \times 7.48}{33 \times 60 \times 60}$$

$$= 1.98 \text{ hrs.}$$

Exercise

1. A lagoon has the surface dimensions of 400 ft. long and 300 ft. wide. The bottom base dimension has a length of 390 ft. and width of 290 ft. The depth is 5 ft. Calculate the average detention time if the average flow per day is 96,800 gallons per day.

2. A clarifier has a volume of 63,500 gallons. The flow rate per day is 802,000 gallons. What is the detention time in hours.

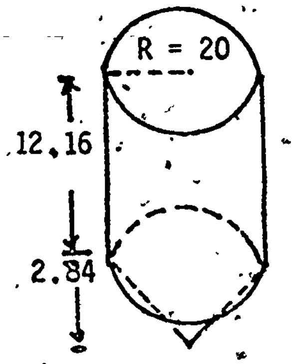
3. A primary settling tank has the dimensions of 30 ft. long, 10 ft. wide and 8 ft. deep. The flow rate is 40 GPM. What is the detention time in hours.

4. A grit chamber has the dimensions of length 16 ft., width 2 ft. and depth of water 3 ft. The flow rate through the chamber is 90 GPS. What is the detention time in the grit chamber.

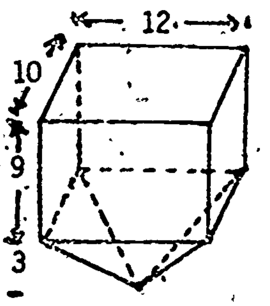
5. A square settling tank 35 ft. x 35 ft. x 7.5 ft. receives a flow of 475 GPM. What is the detention time in hrs.

6. A primary settling tank 55 feet in diameter 8 feet deep receives a flow of 375 GPM. Calculate the detention time in hrs.

7. A digester (see sketch for design and dimension) receives a 2300 gallons of raw sludge daily. What is the detention time in the digester assuming you remove the same amount of digested sludge. (Ans. in days).



8. A settling basin has with dimension (see sketch) receives a continuous flow of 1.08 GPS. What is the detention time in hours.



9. An imhoff tank digestion chamber has a volume of 16,000 ft.^{3} The chamber receives 2,750 gallons of sludge per day what the detention time in days.

10. It takes 4 hours to fill a tank with the dimensions of 45 ft. in diameter and 15 feet in height. At what rate (GPM) is the pump operating.

Module No:	Module Title: Basic Mathematics
	Submodule Title: Detention Time
Approx. Time: 1 hour	EVALUATION

Objectives:

The learner will demonstrate the ability to determine correctly the answers to 8 out of 10 problems related to detention time in water and wastewater units.

1. A plant has a rectangular grit chamber. The dimensions of the tank are 20 ft. length, 5 ft. width and 3 ft. depth. The flow 57.2 MGD. Calculate the detention time in seconds.

   a. 32.08 sec.

   b. 41.67 sec.

   c. 3.39 sec.

   d. 8.54 sec.

2. What is the detention time in a clarifier if the flow rate is 3.8 MGD and the radius of the tank is 30 ft. and the height is 15 ft.

   a. 4 hrs.

   b. 11.98 hrs.

   c. 0.5 hrs.

   d. 2 hrs.

3. A lagoon with an average length of 475 feet and average width of 350 feet has a depth of 4 feet. What is the average detention time if the average daily flow rate is 55,690 gallons?

   a. 89.32 days

   b. 11.94 days

   c. 44.66 days

   d. 62.45 days

4. A tank 65 ft. in diameter, 8.5 ft. deep receives a flow of 300 GPM. What is the detention time.

   a. 2.0 hrs.

   b. 11.7 hrs.

   c. 6 hrs.

   d. 46.86 hrs.

5. In a water treatment plant a settling tank 70 ft. in diameter, 8.5 feet deep receives a flow of 2,320 GPM. Calculate the time.

   a. 42.6 min.

   b. 14.1 min.

   c. 77.4 min.

   d. 105.4 min.

6. In a conventional activated sludge plant the aeration basin has the dimensions of 60 ft. long, 20 ft. wide, 15 ft. deep. The flow to the basin is 281 GPM. What is the detention time in the aeration basin.

   a. 16 hrs.

   b. 6.3 hrs.

   c. 1.06 hrs.

   d. 8 hrs.

7. In Problem 6 if you increase the flow by 25% what is the new detention time.

   a. 1 hr.

   b. 6.4 hrs.

   c. 2.3 hrs.

   d. 3 hrs.

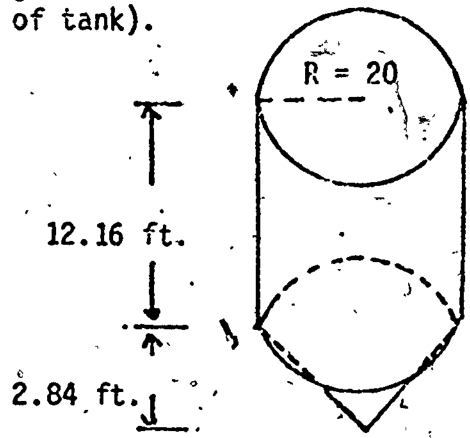
8. Calculate the detention time of a settling basin that receives a flow of 1.05 MGD. (See sketch for dimensions of tank).

a. 2.6 hrs.

b. 3.2 hrs.

c. 2.8 hrs.

d. 1.8 hrs.



9. A 2-cell lagoon operating in series. Cell one has the dimensions of su[illegible] length 500 ft., surface width 400 ft., bottom length 475, bottom width [illegible] Cell two has a surface length of 600 ft. and surface width of 300 feet, bottom length of 580, and bottom width of 290. Both lagoons operate at depth of 5 ft. What is the average detention time if the average daily flow is 303,800 gallons.

a. 12.00 days

b. 45.00 days

c. 90.00 days

d. 60.00 days

10. A chlorine contact chamber has the dimensions of 5 ft. x 5 ft. x 5 ft. If the flow through the chamber is 2.8 MGD what is the detention time.

a. 6.0 sec.

b. 44.6 sec.

c. 28.8 sec.

d. 18.9 sec.

Module No:	Topic: EVALUATION.

Instructor Notes:	Instructor Outline:
1. Handout Answers 1. c 2. d 3. a 4. b 5. d 6. d 7. b 8. c 9. b 10. c	1. Give 10 evaluation problems to be solve